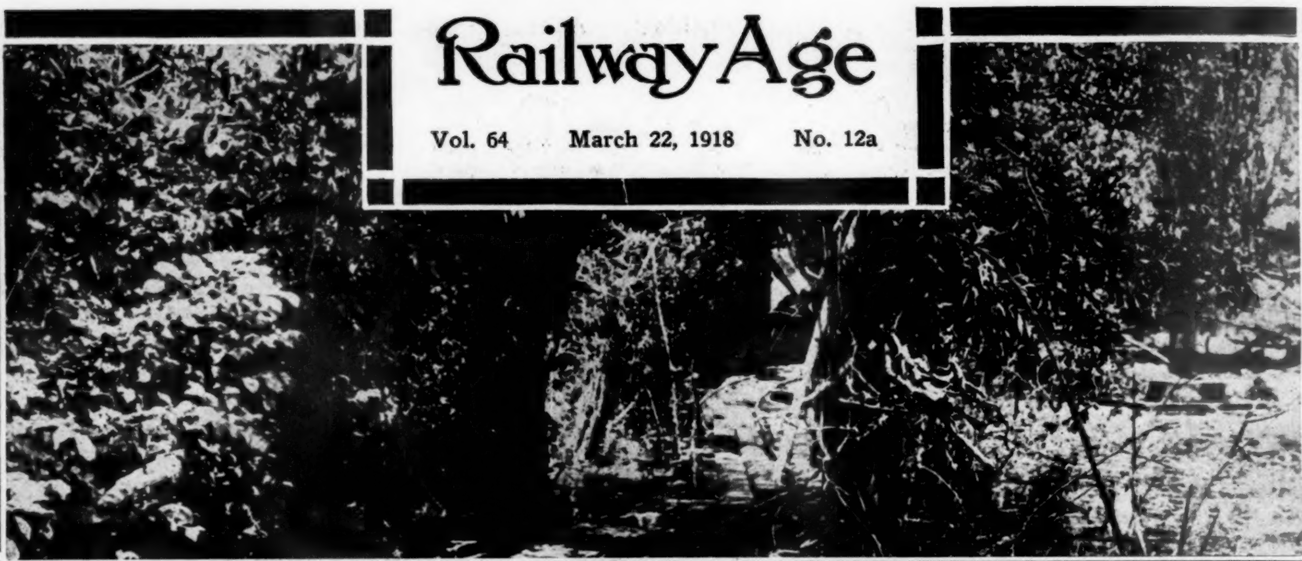
# Railway Age

Vol. 64 March 22, 1918 No. 12a

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# Contents




**Alphabetical Index to Advertisements, page 22.**



Published every Friday and daily eight times in June by the

**Simmons-Boardman Publishing Company, Transportation Building, Chicago**

Edward A. Simmons, *Pres.* L. B. Sherman, *Vice-Pres.* Henry Lee, *Vice-Pres. & Treas.* M. H. Wium, *Secretary.*

**NEW YORK:** Woolworth Building. **CLEVELAND:** Citizens Building. **WASHINGTON:** Home Life Building

Published Daily for Four Days, March 19 to 22, Inclusive, by Simmons-Boardman Publishing Co., Transportation Bldg., Chicago, Ill., on the occasion of the annual convention of the American Railway Engineering Association and the stated meeting of the Railway Signal Association.

## Editorial Staff

Samuel O. Dunn, Editor.
Roy V. Wright, Managing Editor.

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| W. E. Hooper | C. B. Peck | K. E. Kellenberger |
| E. T. Howson | W. S. Lacher | A. G. Oehler |
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Subscriptions, including 52 regular weekly issues and special daily editions published from time to time in New York, or in places other than New York, payable in advance and postage free: United States and Mexico, $5.00; Canada, $6.00; Foreign Countries (excepting daily editions), $8.00; single copies, 15 cents each.

WE GUARANTEE, that of this issue, 7,024 copies were printed; that of these 7,024 copies, 6,375 were mailed or delivered by messenger to regular paid subscribers; 100 were distributed among members and guests of the American Railway Engineering Association and at the Coliseum; 325 copies were provided for office use to fill future orders; 130 copies were mailed to advertisers, and 104 copies were mailed as samples.

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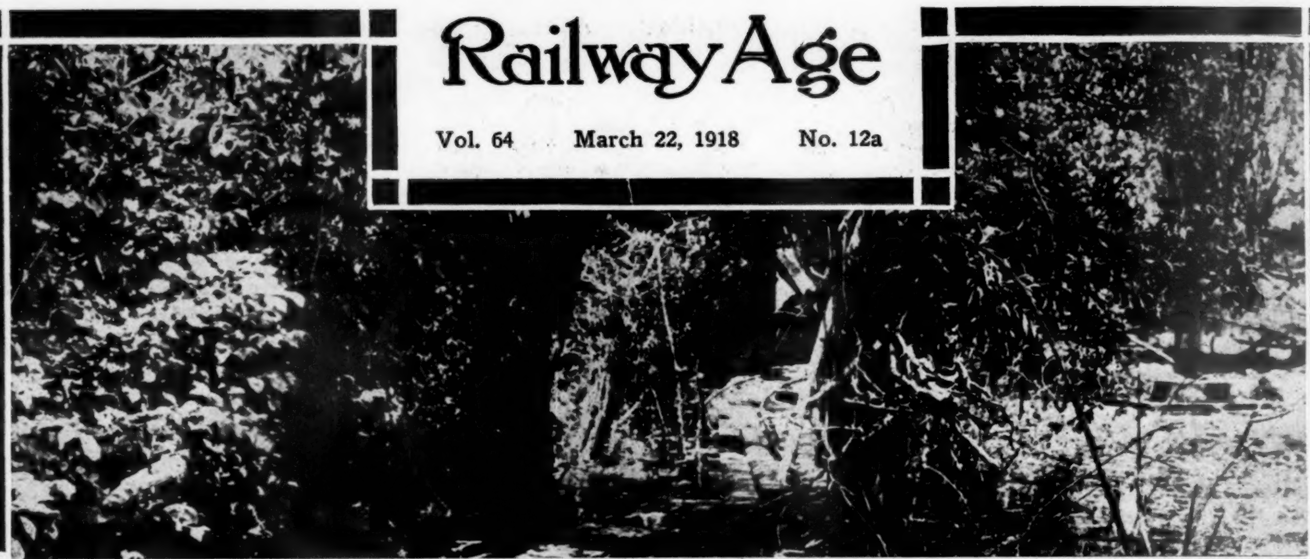

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# EDITORIAL

Railway Age

## DAILY EDITION

**An Excellent Attendance Record**

Further proof of the wisdom of the action of the American Railway Engineering Association in proceeding with this convention is evidenced by the registration of its members. In spite of the statements frequently made by pessimists previous to the convention, that railway men would be so busy that they could not attend the convention, the registration of members for the first day was 293, or 4 more than last year; for the second day 103, for the third day 20, or a total registration of 416 members. Including guests, over 600 railway men attended the meeting. A feature which characterized all of the sessions was the large number of men present in the hall. Although the convention extended well beyond the usual time of closing on Thursday afternoon, over 200 men remained until adjournment and the discussion was active until the close of the meeting. The attendance at the Coliseum was equally encouraging, that on Wednesday being 6,203, and up to 6 p. m. yesterday 2,656. The outstanding feature of this year's attendance was the fact that the people who visited the exhibit showed greater interest in what the exhibitors had to show, this being particularly true with reference to labor-saving devices and economical methods of doing work. Another outstanding feature is the very small attendance of the local public, who have attended the exhibits in fairly large numbers in other years. The attendance this year has been limited almost entirely to railroad officers and men who, realizing the serious conditions existing at the present time, came here to make a thorough and careful study of all devices that can help them to obtain more efficient results.

**Timber and Concrete Trestles Compared**

The report on the comparative merits of ballast and reinforced concrete trestles, resubmitted by the committee on Wooden Bridges and Trestles after reconsideration by that body since its original presentation last year, revives a controversy between the advocates of these two types of structures which was carried on at some length at previous conventions, notably in 1911, when the committee on Masonry submitted a report on reinforced concrete trestles. As presented so lucidly in the report considered yesterday, the problem is purely one of the relative life as compared with the relative costs of the two structures, for, as pointed out in the report, "even though actual installation costs of the two structures under comparison are lacking, their relative ultimate economy can be computed as a ratio of the two costs regardless of the numerical value thereof." There are, however, other factors that enter into a consideration of this subject, some of which have been discussed in detail at previous conventions. Among these may be mentioned the appearance; relative sense of security or solidity as affecting the traveling public; fire hazard, etc. The life to assume in the case of "permanent" structure is also a question. There is a stone arch viaduct on the Baltimore & Ohio that has been in service since 1829 and is apparently good for many years to come. On the other hand, many structures have been abandoned in connection with grade and line revisions after very limited periods of service. The contention in the discussion yesterday was entirely concerned with the principles of economics involved. As long as the same method of financing is assumed in each case, the results to be obtained with the use of the several formulæ are the same. Just which method is correct seems to be still a matter of question, and in view of this, the action of the association in adopting both analyses for publication in the Manual seems well taken.

**More Foreign Passes Required**

Obviously the convenience of railway officers and employees cannot be taken into consideration in the program for curtailing passenger service now being undertaken to expedite the movement of freight. Nevertheless, a reduction in the number of passenger trains will tend to reduce the efficiency of many employees of the engineering and maintenance of way departments. While railway officers, including the division engineer, are usually supplied with annual passes on neighboring roads, enabling them to make the most of the train service on adjoining lines in the same territory, it has not been customary to make similar provision for men in subordinate positions. Reductions in passenger service will not only work a hardship on the men not now enjoying the privilege of foreign passes whose duties take them over various parts of the line, but even with a material increase in night traveling the proportion of their time devoted to effective employment will suffer a pronounced decrease. It is true that such men are commonly accorded the privilege of riding on freight trains, but with time freights making only a limited number of stops and tonnage trains moving at low speeds, the use of freight trains will fall far short of compensating for the reductions in the passenger train service. The natural remedy for this situation would seem to be an extension of the foreign pass privilege to the men in the subordinate positions. With the unified operation obtaining under government control there would seem to be less objection to this practice than under normal competitive operation, while the unavoidable abuses of such transportation can be reduced to the minimum by limiting the passes to the territory in which the employee can make use of them in his daily work.

**Work of Committee on Iron and Steel Structures**

The announcement of the Committee on Iron and Steel Structures that it has undertaken the revision of the Association's General Specifications for Steel Railway Bridges is an evidence of the progress that has been made in steel railway bridge design since the adoption of these specifications in 1906. That these rules for bridge design fulfilled a definite need is indicated by their very general acceptance throughout the country. It is also in keep-

ing to call attention to the fact that much of the progress which is rendering these specifications obsolescent is the direct result of the efforts of this same committee.

Chief among the results secured through its efforts has been a determination of the actual impact influence of moving trains. The committee has supplied definite information on a subject which was formerly a matter of pure conjecture. Further progress on this subject is contained in the contemporary report and demonstrates specifically that the influence of electric locomotives is materially less than that of steam locomotives of the usual types. While the committee indicates that further work must be done on the subject of secondary stresses before the information now at hand can be made available for general use, it has already done much to clear up this perplexing subject.

In giving this committee credit for the work it has done, it is necessary in all fairness to mention the epoch making work of the Special Committee on Columns of the American Society of Civil Engineers, the results of which were made available early this year. The report on column tests presented by the A. R. E. A. committee this year contains information which is in a measure supplementary to the work of the A. S. C. E. committee.

## A Great Opportunity

THE AMERICAN RAILWAY ENGINEERING ASSOCIATION is entering the most important and the most critical period in its history. Never before has it been confronted with greater responsibilities or with larger opportunities for constructive work. The extent to which it will measure up to its full opportunities will be determined largely by its actions during the next few months.

The association is now entering the twentieth year of its existence. A study of the proceedings of the annual meetings and the Manual cannot fail to impress one with the wide range and the high value of the work which has been done. The fact that these volumes are to be found in the libraries of almost every railway officer having to do with engineering and maintenance of way matters in this country indicates the high esteem in which they are held.

The entrance of the United States into the world war last April has led to radical changes in conditions in every line of activity. No industry has been affected more directly or more deeply than the railroads. These changes are creating new problems in all branches of railway service, not excluding the engineering department. It is now the primary duty of all organizations to concentrate on the solution of the main problem confronting this country—that of winning the war. The Engineering Association made important progress in this direction during the past year, as was evidenced during the meeting which closed yesterday afternoon. The committee on Yards and Terminals presented a valuable questionnaire on yard improvements for use by railway officers confronted with the problem of increasing the capacity of their yards with minimum changes. The discussion of the report of the committee on Iron and Steel Structures was directed largely toward means of carrying structures over rather than renewing them under present conditions. The committee on Economics of Railway Labor also reported on certain phases of the labor problem which is now of paramount importance.

The coming year will present to this association greatly enlarged opportunities for service. In order to be of the maximum value to its members, to the railways and to the government it may be necessary to modify existing practices and to disregard long-established precedents, but this has been almost universally necessary in every activity. The Board of Direction can do much to facilitate the war-time activities of the association by giving primary consideration in the assignments of subjects, to the selection of those topics which are of the greatest importance in the light of present day conditions.

It may also be considered advisable to issue advance reports or bulletins on certain subjects for which there is a demand for immediate information without attempting to hold them for the annual convention. Conditions are changing so rapidly and the association has such an excellent opportunity for collective work that it would seem eminently fitting to take up for consideration some of the more pressing problems and, by concentrating the attention of certain committees upon them, to prepare reports for presentation very early. A considerable amount of valuable information regarding labor saving devices was developed during the discussion of that part of the report of the committee on Economics of Railway Labor bearing on that subject and it has been suggested that an attempt be made to collect all of the available material of this character into a booklet for publication within the next few weeks. This is illustrative of similar opportunities in other phases of the work.

Since the government has assumed control of the railroads and is now directing their operations it must necessarily assume responsibility for the maintenance of these properties. This in itself will give rise to many problems. The director-general has shown his desire to call upon railway men and railway organizations for assistance in the solution of his problems. The American Railway Engineering Association has been engaged in the study of maintenance of way problems for 20 years. It includes in its membership almost all of the more prominent railway engineers in the country. Its proceedings, therefore, may fairly be considered to represent the consensus of opinion regarding best practices in engineering and maintenance of way matters. As expressed in the resolution passed yesterday afternoon the association has offered to co-operate with the director-general in any way in which it can be of assistance and it is very probable that he may desire to call upon this organization for information concerning practices already established as well as to practices which are still in the process of development.

## The Effect of Speed on Maintenance Charges

IN UNDERTAKING AN ANALYSIS of the influence of the speed of trains on the cost of maintenance the Track committee has directed its attention toward a problem, the solution of which will be of much importance to the railways. It is a matter of common knowledge among railway men that a high-speed train is more destructive to track than a slow one. The difficulty has been in determining the amount of this increased destruction.

This question has been brought prominently to the front in litigation relative to passenger fares in a number of middle western states. Following the general enactment of two-cent fare legislation in these states a few years ago, the roads have attempted to prove that these rates were confiscatory. This has made necessary an analysis of operating expenses and the allocation of these expenses to the various classes of traffic. Many of the operating expenses can be charged directly to the

traffic giving rise to them. Others cannot be divided so readily. This is particularly true of a large part of the maintenance of way expenditures for the tracks are used in common by trains of all classes. These expenses must be distributed on some arbitrary basis and the difficulty has been to arrive at a basis which can be mutually agreed upon between the representatives of the railroads and the states as fair and equitable.

In their desire to prove the reasonableness of low passenger rates, the states have contended for a low distribution of maintenance expenses chargeable to passenger traffic, while the representatives of the railroads have contended for a high ratio which would add to the expenses of passenger traffic, and tend to prove that the rates were unreasonably low. In one instance a state has endeavored to maintain the position that the distribution should be on the basis of the gross ton miles of freight and passenger traffic, in this way disregarding entirely the effect of speed. This is typical of conditions which exist in a number of states and of controversies which will rise in the future because of the present tendency to make each class of service bear its full proportion of operating costs. The Track committee has cut out for itself a hard problem, but its proper solution will be of great value to the roads.

## Illinois Central Signal Men at Coliseum

The Illinois Central signal department was well represented at the Coliseum, nine out of eleven of its signal supervisors attending the exhibit, in addition to seven foremen and a large number of maintainers, helpers and repairmen.

## W. C. Pembroke Promoted

W. C. Pembroke, assistant engineer of the Coal & Coke railway, with headquarters at Gassaway, W. Va., has been appointed engineer maintenance of way with the same headquarters, succeering A. C. Hawkins, who has resigned.

## Signal Department Changes

J. W. Peck, signal supervisor of the Missouri, Kansas & Texas with headquarters at Waco, Tex., has been appointed general signal inspector of the Chicago Great Western with office at Chicago. J. A. Murrell, signal foreman, has been appointed supervisor to succeed Mr. Peck.

## A. R. Eitzen Appointed Bridge Engineer on "Katy"

Arthur R. Eitzen, formerly office engineer in the bridge department of the Kansas City Terminal railway, and more recently with the Kansas City Bridge Company, has been appointed bridge engineer of the Missouri, Kansas & Texas with headquarters at Dallas, Texas.

## Union Pacific Promotions

C. B. Segar, vice-president and controller of the Union Pacific system, was elected a member of the executive committee, and also acting chairman of the committee, succeeding R. S. Lovett, resigned, to become director of the Department of Capital Expenditures on the staff of Director-General McAdoo. He was also elected a member of the executive committee and acting chairman of the Oregon Short Line and the Oregon, Washington Railroad & Navigation Company. W. A. Harriman, vice-president, was made a member of the executive committee of the Union Pacific, and also elected a director of the Oregon Short Line, succeeding Mr. Lovett. C. A. Peabody, vice-president of the Delaware & Hudson, was elected a director of the Oregon-Washington Railroad & Navigation Company, succeeding Mr. Lovett.

## Changes in Illinois Central Signal Organization

P. G. Pendorf, formerly signal supervisor of the St. Louis division of the Illinois Central at Centralia, Ill., resigned effective March 16 to accept a position with the sales department of the Buda Company, with headquarters at Chicago. E. E. Goddard was appointed signal supervisor in his place. Mr. Keller has been appointed signal supervisor, with headquarters at Champaign, Ill., effective March 16.

## Orders of Railroad Administration Regarding Capital Expenditures

(From Our Washington Correspondent)

President Wilson yesterday (Thursday) signed the Railroad Control Bill.

Designs for standard cars and locomotives have been practically approved. They were gone over by the regional directors Monday and Tuesday and the final specifications are being revised in Pittsburgh this week for submission to the director-general next Monday.

Director-General McAdoo yesterday issued General Order No. 12, giving rules to be observed with respect to railroad work involving charges to capital account. He declared it is important to avoid expenditures not absolutely necessary. The construction of new lines, branches or extensions is not to be entered upon without the director-general's approval.

No new locomotives or cars are to be ordered or constructed without the director-general's approval.

Work contracted for or started before January 1 may be continued. No work involving charges to capital account of more than $25,000 shall be contracted for unless authorized by the director-general.

## Changes on the Salt Lake Line

Owing to the practical cessation of construction work and the approaching completion of the valuation work on the Los Angeles & Salt Lake, the office of engineer of maintenance has been consolidated with that of chief engineer and the duties have been assumed by Arthur McGuire, chief engineer. R. K. Brown, engineer maintenance, has been appointed division engineer at Salt Lake, succeeding Frank Strong, who has resigned to enter military service. W. H. Comstock, secretary of the Los Angeles & Salt Lake, has been appointed acting general manager, succeeding H. C. Nutt, general manager, granted leave of absence to accept a commission as major with the railway forces in France.

### Fitzpatrick for Protection

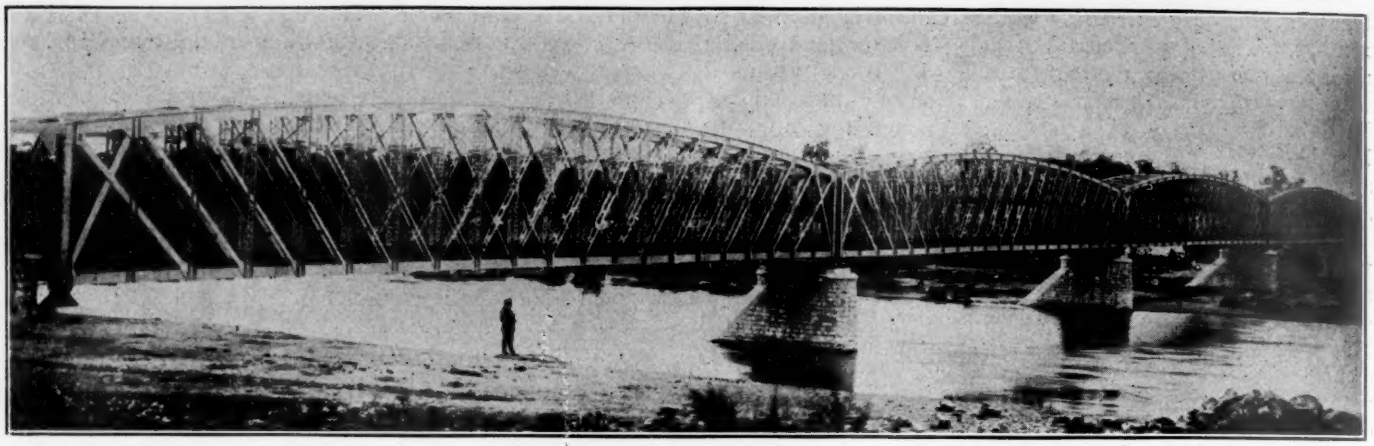
"What's your name?"
"Isaac Fitzpatrick Cohen."
"What's the Fitzpatrick for?"
"For protection."

### Under U. S. Control

Inquirer (at South Station, Boston): "Where does this train go?"

Brakeman: It goes to New York in ten minutes."

Inquirer: "Goodness! That's going some!"



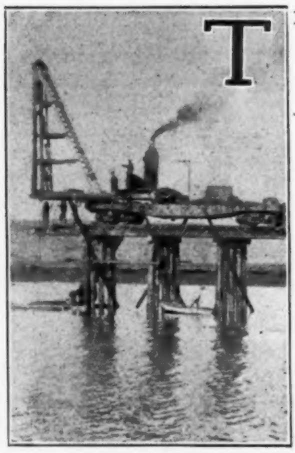
*Bridge Over the River Khor in Siberia Over Which Japanese Forces May Move* *Copyright by Underwood & Underwood, New York*

# American Railway Engineering Association Proceedings

### A Report of Thursday's Sessions Including the Presentation of Ten Committee Reports With Discussions

THE FINAL SESSIONS OF THE American Railway Engineering Association were held on Thursday. The morning meeting was called to order promptly at 9:30 by President Sullivan. Owing to the large amount of time taken up in the discussion of the report on Wooden Bridges and Trestles, seven reports were held over for the afternoon session. Final adjournment was taken about 5:30. The abstracts of the reports and discussion of the various subjects considered are given below:

## Report of Committee on Wooden Bridges and Trestles



THE COMMITTEE RECOMMENDED the following revisions in the Manual:

(1) In the standard specifications for Southern yellow pine bridge and trestle timber, change the heading, "Standard heart grade, longleaf yellow pine," above paragraph 4, on page 231, to read, "Standard heart grade, dense yellow pine," and change the heading, "Standard grade, longleaf and shortleaf yellow pine," above paragraph No. 10, on page 232, to read, "Standard grade, sound yellow pine." This is to conform to the classification of yellow pine timber as adopted by the Association in 1916.

(2) That all illustrations, tables and diagrams in the Manual be designated by the number of the page on which they appear, instead of being numbered consecutively, using subscripts when more than one reference appears on any single page.

(3) On page 246, change the last part of paragraph No. 2, "The inner guard rail should not be higher or over one inch lower than the running rail," to read, "* * * should not be higher or more than one inch lower * * *"

(4) On page 232, paragraph No. 9, and on page 241, paragraph No. 26, change the term "guard rails" to "guard timbers" to conform to the definitions given on page 220 and to the use of the term of page 234, paragraph No. 6.

### Comparative Merits of Ballast and Reinforced Concrete Trestles

All conclusions of the committee's report of last year were adopted by the Association except one, namely: "Creosoted Timber Trestles are more economical than concrete, except when the cost of the concrete structure is less than one and one-half times the cost of the wooden structure."

Upon presentation of the report to the convention considerable discussion occurred, the general purport of which was that this conclusion should be reconsidered by the committee, principally with respect to the method employed in reaching the results.

The suggestion has been made that the sinking fund method is more nearly correct in principle for indicating the comparative ultimate economy than the method used by the committee and heretofore called the "Capitalization Method." Accordingly, much effort and study has during the past year been devoted to the practical effects of the application of the methods to the problem at hand, and the committee desires to present to the Association the results of its endeavors along this line, both for the specific purpose under discussion and for other purposes of a similar nature.

To ascertain whether application of the sinking fund method of financing in matters of the kind under discussion is generally used or advocated by railway officers, the chairman of the committee sent out 154 inquiries. Out of a total of 122 replies, answering for an aggregate of

218,078 miles of line, received thus far, but one, covering a total of 2,085 miles, or less than 1 per cent., reports the use of the sinking fund method; eight, with a mileage of 13,002, or 6 per cent., while not using it, deem it desirable or have it under consideration; 121 reporting for a total of 215,993 miles of line, or more than 99 per cent., indicate no actual application whatever. It would seem, therefore, improper to assign any merits to the method on the grounds of widespread favor or extended use as representative of good practice.

From the replies received to the committee's inquiry, it appears that, with one exception, all roads either (a) set aside a reserve in their working capital to provide for renewals, or else (b) replace structures with money from current funds or money borrowed for the purpose at the time the structure needs renewal. Note that (a) is the sinking fund method, with interest return not less

CAPITALIZATION METHOD

**COMPARATIVE ECONOMIC VALUE**
**BALLAST DECK TRESTLES**

w – Cost of Wooden Trestle.
c – Cost of Concrete Trestle.
r – Rate of interest.
m – Life in years of wooden trestle
n – " " " " concrete "
x – Amount capitalized which will replace wooden trestle every m years.
y – " " " " " concrete " " n "
f – Ratio of first cost of concrete trestle to first cost of wooden trestle to produce equal ultimate economy, that is
$f = \frac{c}{w}$ or $fw = c$

Then $x(1+r)^m = w + x$ and $y(1+r)^n = c + y$, whence $x = \frac{w}{[(1+r)^m - 1]}$

and $y = \frac{c}{[(1+r)^n - 1]} = \frac{fw}{[(1+r)^n - 1]}$

To produce equivalent ultimate economy $w + x = c + y$, which by substituting values of $x$ and $y$ gives

$$w + \frac{w}{[(1+r)^m - 1]} = fw + \frac{fw}{[(1+r)^n - 1]}$$

Dividing by w and solving for f it is found that

$$f = \frac{1 + \frac{1}{[(1+r)^m - 1]}}{1 + \frac{1}{[(1+r)^n - 1]}}$$

which is variable only with respect to m and n the assumed lives of wood and concrete. By using as an argument first cost of wooden trestle with a constant life regardless of such cost, the first cost of a concrete trestle with a life of n years is found by applying to cost of wooden trestle the coefficient f determined for n years.

**Analysis of Relative Economy of Wooden and Concrete Trestles**

than the cost of borrowed money, which method has been shown to be identical in ultimate cost with the capitalization method, while (b) is the method in most general use and is herein called the replacement method. Computing the total cost by the replacement method, it also is found to be identical with the capitalization method.

It appears, therefore, that the capitalization method proposed by this committee is virtually in use to-day by practically all roads.

(1) The sinking fund method is identical with the capitalization method when the interest rate on annuities is the same as the interest rate on the original investment cost, which equality of interest rate is logical, desirable and imperative for the conservation of finance.

(2) There is not only improvidence but extravagance in the use of the sinking fund method with a lower rate of interest in financing the recurring renewals of perishable structures.

(3) Wider departure between actual monetary demands and available financial provision therefore occurs with the sinking fund method, as compared with the capitalization method, if an error has been made in expected length of life.

(4) That the sinking fund method, by reason of its extended use and general favor, should be adopted in comparing ultimate economy of railway structures is entirely unwarranted.

(5) The sinking fund method is cumbersone, complex and difficult of strict application in practical use, while the capitalization method is relatively simple and meets with equity every requirement necessary for comparative purposes.

(6) The capitalization method is virtually the only method in use to-day.

*Current Maintenance and Inspection*

It is impossible to secure reliable figures for the cost of repairs to keep in serviceable condition throughout their lifetime ballast deck creosoted trestles, principally because no record thereof has been kept for sufficiently long periods to establish any basis for computation. No additional data of value for this factor of the case could be collected during the year. With respect to the extra cost of maintenance of way and structures, due to keeping free from dry grass, weeds or other inflammable debris the right-of-way at the bridge site, the committee has already expressed its judgment that such service should be equally well performed whether the trestle is a concrete or wooden structure, and, therefore, should be neglected in a comparison of the two types. This opinion is based on very obvious requirements of eliminating hazard of fire damage to contiguous property, both of railway and others, and of general neatness and thrift. Finally, we may add with propriety, that concrete structures will not be entirely free from charges for maintenance and inspection.

*Insurance*

Attention is directed to the committee's discussion of "Fire Hazard" in the report of last year, to the effect that there is little probability of fire loss in the ballast deck timber trestle. During the year inquiries have been sent out to the larger railways of the United States and Canada, in an endeavor to ascertain current practice with respect to whether insurance is placed on either open deck or ballasted deck timber trestles, and if so, whether a difference in percentage of value for which the two types of wooden trestles are insured prevails. Out of a total of 157,673 miles of line reporting, 69,039 miles, or 43.8 per cent., carried no insurance on such structures; 28,623 miles, or 18.2 per cent., maintain their own insurance fund; 60,011 miles, or 38 per cent., insure with outside companies. While generally it seems to be the practice of roads using both open deck and ballasted deck trestles not to differentiate between the two kinds, either in percentage of value insured or rates paid therefor, we find there is so great a divergence in such rates paid by the several lines that no general rule is applicable. It is evident, however, that with the prevalent low insurance rates and drafts, inconsiderable in magnitude and infrequent in occurrence, on company insurance funds, we are not justified in introducing into the question of ultimate economy any numerical value for a factor of so uncertain and elusive a character. It seems to us far better to point out the probable degree of fire hazard to be considered in the adoption of type

rather than to attempt the assignment of what must necessarily be a speculative monetary value thereto, and this course has been followed.

*Conclusions.*

Attention is invited to the committee's recommended disposition of its report of last year of all these uncertain and indeterminate factors, which were mentioned in detail, and we beg to submit briefly a repetition of such recommendation, based on the following considerations:

(1) The capitalization method properly shows the relative worth of the capital invested in structures of different serviceable lives and is, therefore, a desirable criterion for comparing ultimate economy.

**Comparative Cost of Installation of Ballast Deck Trestles per Linear Foot to Produce Equivalent Economic Value; Interest at 6 Per Cent. Per Annum Assuming Creosoted Timber Trestle Will Serve 20 Years.**

| CREOSOTED TIMBER SERVICE LIFE | JUSTIFIABLE EXPENDITURE FOR CONCRETE SERVICEABLE FOR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20 YEARS | 30 Yrs | 40 Yrs | 50 Yrs | 60 Yrs | 70 Yrs | 80 Yrs | 90 Yrs | 100 Yrs |
| $10.00 | $12.00 | $13.09 | $13.74 | $14.09 | $14.28 | $14.39 | $14.46 | $14.49 |
| 11.00 | 13.20 | 14.39 | 15.12 | 15:50 | 15.71 | 15.83 | 15.90 | 15.94 |
| 12.00 | 14.40 | 15.70 | 16.49 | 16.91 | 17.14 | 17.26 | 17.35 | 17.39 |
| 13.00 | 15.60 | 17.01 | 17.86 | 18.32 | 18.57 | 18.70 | 18.79 | 18.83 |
| 14.00 | 16.80 | 18.32 | 19.24 | 19.73 | 20.00 | 20.14 | 20.24 | 20.28 |
| 15.00 | 18.00 | 19.63 | 20.61 | 21.14 | 21.43 | 21.58 | 21.68 | 21.73 |
| 16.00 | 19.20 | 20.94 | 21.99 | 22.54 | 22.86 | 23.02 | 23.13 | 23.18 |
| 17.00 | 20.40 | 22.24 | 23.36 | 23.95 | 24.28 | 24.46 | 24.57 | 24.63 |
| 18.00 | 21.60 | 23.55 | 24.74 | 25.36 | 25.71 | 25.90 | 26.02 | 26.09 |
| 19.00 | 22.80 | 24.86 | 26.11 | 26.77 | 27.14 | 27.34 | 27.46 | 27.53 |
| 20.00 | 24.00 | 26.17 | 27.48 | 28.18 | 28.57 | 28.77 | 28.91 | 28.98 |

(2) In the absence of authentic data as to cost of current maintenance, inspection, insurance and uncertain renewal cost of both or either of two types of structures, the annual expense of upkeep should evidently be omitted in any comparative statement of cost, leaving the relative influence thereof to be considered by the investigator.

The committee has been guided by these two principles in reporting its conclusions—the first in using the capitalization method for indicating the justifiable expenditure in installation costs of concrete trestles to produce ultimate economy equivalent to various installation costs of creosoted timber trestles, and the second in its suggestion as to the assumed life of the timber structure to be used as the argument, for notwithstanding the practical unanimity of the best authorities in that the creosoted structure will last 25 years, it has recommended to the Association the use of a 20-year life in considering economic value. This arbitrary reduction in assumed life of timber trestle we think ample to compensate for the indeterminate elements and consider further refinement totally unnecessary, especially since there is likely to be a difference of opinion, even to the extent of 100 per cent., in the assumption as to the probable life of the concrete.

We, therefore, believe conclusion No. 6 of last year's report wholly warranted, and, after thorough reconsideration, again recommend its adoption for printing in the Manual in the order and substance as therein stated: "Creosoted timber trestles are more economical than concrete, except when the cost of the concrete structure is less than 1½ times the cost of the wooden structure."

A recommendation is also made for the adoption by the Association for printing in the Manual of the formula for the capitalization method.

In order that the members may also have at hand for convenience in any purpose for which applicable all the results of the committee's work, it is further recommended that the statement of ratios of installation costs developed by the capitalization method be adopted and printed in the Manual.

**Ratio of Installation Costs of Structures to Produce Equivalent Ultimate Economy in Their Perpetual Maintenance. Based on an Interest Rate of 6 Per Cent. Per Annum for Capital Invested Therein, and Neglecting Costs of Repairs.**

| SERVICE LIFE YEARS | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 3.94491 | 2.25779 | 1.71099 | 1.44880 | 1.29994 | 1.20725 | 1.10721 | 1.05429 | 1.02822 | 1.01422 | 1.00702 | 1.00234 | 1.00000 |
| 90 | 3.93569 | 2.25251 | 1.70699 | 1.44551 | 1.29690 | 1.20442 | 1.10462 | 1.05182 | 1.02582 | 1.01185 | 1.00467 | 1.00000 | — |
| 80 | 3.91741 | 2.24205 | 1.69906 | 1.43869 | 1.29087 | 1.19883 | 1.09949 | 1.04694 | 1.02105 | 1.00715 | 1.00000 | — | |
| 70 | 3.88960 | 2.22613 | 1.68700 | 1.42848 | 1.28171 | 1.19032 | 1.09168 | 1.03951 | 1.01380 | 1.00000 | — | | |
| 60 | 3.83663 | 2.19582 | 1.66403 | 1.40903 | 1.26426 | 1.17411 | 1.07682 | 1.02771 | 1.00000 | — | | | |
| 50 | 3.74177 | 2.14153 | 1.62288 | 1.37419 | 1.23300 | 1.14508 | 1.05019 | 1.00000 | — | | | | |
| 40 | 3.56295 | 2.03918 | 1.54532 | 1.30852 | 1.17407 | 1.09035 | 1.00000 | — | | | | | |
| 30 | 3.26770 | 1.87020 | 1.41727 | 1.20008 | 1.07678 | 1.00000 | — | | | | | | |
| 25 | 3.03470 | 1.73684 | 1.31621 | 1.11451 | 1.00000 | — | | | | | | | |
| 20 | 2.72290 | 1.55840 | 1.18098 | 1.00000 | — | | | | | | | | |
| 15 | 2.30564 | 1.31958 | 1.00000 | — | | | | | | | | | |
| 10 | 1.74725 | 1.00000 | — | | | | | | | | | | |
| 5 | 1.00000 | — | | | | | | | | | | | |

This statement is developed from formula in Addenda (1), Analysis No. 1.

### Use of Lag Screws in Trestle Construction

For several years the committee has had the subject of lag screws under investigation. A comparison of the best methods of application has been made the subject of careful study. Early in 1914 various inquiries were sent to a large number of carriers throughout the country, outlining to them the desire of the committee and requesting certain information to enable it to further study the merits of lags. The constant aim of the committee has been to locate the source of trouble where lags had been in use, and later discarded on account of not meeting requirements.

A study of the 131 replies received to inquiries of the committee, aggregating 203,000 miles of railway, showed that 103 roads, with a combined mileage of 159,000 miles, never used lag screws in any form, while 28 roads, with a combined mileage of 44,000 miles, had used them in some form or other with varied success. To formulate a more conclusive comparison, another circular was sent to such carriers as had not yet used lags to induce them to make a test along lines outlined by the committee. Of the 75 replies received in answer to this circular, 37 roads, with a combined mileage of 74,000 miles, indicated their willingness to make a test of lag screws along such lines and under such instructions as the committee might direct. A plan was prepared illustrating the recommendations of the committee. On this same plan there were shown designs illustrating the practice of a few of the roads relative to their method of use of lags. This plan was sent to each of the 37 roads previously express-

ing its willingness to give lags a trial on one or more structures on the line of its road. To this request, 17 roads, with a combined mileage of 39,600, complied and reported the results of their test to the committee. Only two of these roads reported in any way adversely, while the large majority of them were convinced that lags had certain advantageous features not common to bolts.

The principal features of the test, as recommended by the committee, are the elimination of the dapping of guard timbers and ties, and the use of lags in each tie with a drift bolt in each second tie to securely fasten the tie to the stringer. It is also evident from an examination of the plan that the lining of the track on the stringers is materially simplified, since there is no dapping of ties over stringers to interfere.

Where the suggestions of the committee were followed in the test almost universal satisfaction was obtained.

### Conclusions

1. The committee recommends that the changes in the Manual be adopted.

2. The committee recommends that the following conclusions in regard to the use of lag screws in trestle construction be adopted and published in the Manual:

(a) Lag screws require greater care than ordinary bolts and nuts to properly install, but are cheaper on account of ease of application.

(b) Lag screws, where properly applied, hold ties from bunching equally as well as bolts and nuts, and better than daps, in timber guard rails.

(c) If the lag screws are tightened after timber has shrunk, there is less cost of maintenance than with bolts and nuts.

(d) Use of lag screws renders unnecessary the dapping of guard timbers, and, therefore, decreases cost of trestles without impairing quality.

(e) Surfacing (sizing) ties and guard timbers is better construction than dapping; makes a better riding track, thus decreasing impact stresses, and is therefore good practice.

(f) For proper application of lag screws, holes in guard timbers should be bored with auger bits $\frac{1}{16}$ in. less in diameter than the nominal size of lag screws used.

The committee recommends the following subjects for next year's work:

1. Revision of the Manual.—Revise the table of recommended stresses on page 244 of the Manual and enlarge it to include stresses in treated timber.
2. Revision of Manual.—Consult with the Committee on Grading of Lumber and prepare changes required to eliminate duplication.
3. Continue study of details of docks and wharves.
4. Select the best types of timber trestles and prepare standard details.

Committee: E. A. Frink (S. A. L.), chairman; W. H. Hoyt (D. M. & N.), vice-chairman; F. Auryansen (L. I.), H. C. Brown, Jr., A. D. Case (B. & A.), A. H. Freygang (B. & O. S. W.), E. A. Hadley (M. P.), F. F. Hanly (B. & O.), G. A. Haggander (C. B. & Q.), H. T. Hazen (C. N.), C. S. Heritage (K. C. S.), A. O. Ridgway (D. & R. G.), F. S. Schwinn (I. & G. N.), C. S. Sheldon (F. M.), I. L. Simmons (C. R. I. & P.), D. W. Smith (H. V.), A. M. Van Auken (M. C.), W. H. Vance (St. L. S. W.), D. R. Young (D. L. & W.).

### Discussion

(Earl Stimson, B. & O., presiding.)

E. A. Frink (Chairman): The Board of Direction assigned four subjects to the committee for this year's work. I do not think it necessary to read any of this preliminary matter.

The first thing I will call your attention to is the revision of the Manual and Appendix.

The committee recommends four changes in the wording of the Manual. These do not make any changes in the subject matter of the Manual, but the first one simply makes the specification of the Committee on Wooden Bridges and Trestles agree with the standard wording of the Yellow Pine Rules that we have adopted.

(Mr. Frink then read the matter under appendix A.)

Mr. Frink: I move the adoption of the changes recommended by the committee.

C. W. Baldridge (Santa Fe): Does that motion cover all four sections?

The Vice-President: All except No. 2.

Mr. Baldridge: In No. 3, in which they propose a change of importance, in regard to the inside guard rail, providing that the inside guard rail should not be higher or over one inch lower than the running rail. I think that is important, and suggest that the words "or more than one inch lower" be omitted, and that you make a little wider variation.

Mr. Frink: The change the committee makes completes the meaning of the clause now in the Manual. We are not changing the provision now in the Manual, we are making it clear and grammatical. It now says "the inner guard rail should not be higher or over one inch lower than the running rail."

The expression "one inch lower" does not seem good sense, and we want to make it something that is sensible, and that is the only purpose of the change. If the convention desires a revision of the inner guard rail specifications, that is another matter.

Mr. Baldridge: If I am not mistaken the present minimum height fixed was adopted prior to the adoption of our present heavy rail section, and it seems to me in view of the height of the heavy rail sections, a change should be made in the minimum height permissible for inner guard rails. A high guard rail has one disadvantage, in that it is more likely to follow the arch bar bolts or anything hanging down over a track, and if the truck is derailed, it may prevent the guard rail from acting as it should. I thing we should alter the minimum height in line with the heavier rail sections, which are now recommended.

The Vice-President: The committee will consider that during the coming year.

(The motion made to adopt the four recommendations was put to vote and carried.)

Mr. Frink: The second subject assigned to the committee this year was to report on Docks and Wharves. We are now planning various details of wharf structures as a beginning, but are not prepared to make anything but a progress report on this subject.

The third subject was to report on the comparative merits and economic features of ballast deck and reinforced concrete trestles. In appendix B you will find a full discussion of the question and the reasons which led us to bring back to you the same conclusion we presented last year. I move that this section be adopted and printed in the Manual.

J. G. Sullivan (C. P.): I discussed this matter last year, and I want to say that it has been not so much a difference of opinion, but a misunderstanding on the part of the committee of the stand I took at that time. That there may be no misunderstanding, you will note that the committee says: "The replacement method consists in renewing a structure with new money or with funds taken from operating income. This method is in practically universal use in this country." That, I think,

is a fact. "The capitalization method as used by the committee is the investment of a fund of such an amount and in such manner"—now, mark this—"is the investment of a fund in such amount and in such maner that the accumulation of interest thereon will periodically amount to a predetermined sum." I think that is correct, and exactly the idea I had of the capitalization method. The committee further says, "The Sinking Fund as used in the Sinking Fund Method employed by this committee is a fund accumulated by equal periodical increments invested in such manner that at the end of a certain cycle the total will amount to a predetermined sum." That also is a statement of fact.

Now the committee says: "The Sinking Fund Method is identical with capitalization method, when interest rate on annuities is same as interest rate on original investment cost, which equality of interest rate is logical, desirable and imperative for the conservation of finance." I do not know what that has to do with the problem under consideration, when you are figuring to decide in your own mind what you are going to do.

Another difference of opinion is that the comimttee has evidently understood that because I said in our company and in our experience, to be on the safe side I figured the interest on our sinking fund or reserve, or whatever you call it, at a lower rate of interest—because I made the mistake, if it was one, of working on the conservative side, and figuring at a lower rate of interest, it did not by any means vitiate the method.

The committee then sent out a circular letter to all of the railways to find out, as they said, how many roads use the sinking fund method. They found that only one or two roads use the sinking fund method, but all the other roads wrote they believed it was the proper method to apply.

But had they asked the question, how many roads did their financing on the capitalization method, I venture to say that they would not have got one single solitary positive answer.

I have never heard of any concern, commercial, railroad or any other concern, doing business on such a basis. I have shown this discussion to two or three prominent railroad auditors and vice-presidents in charge of finance, and they seemed to pooh-pooh the idea of any commercial business being done on that method.

To sum up, the committee admits that if you take the same rate of interest, the results will be identical. Of course, they must be identical. That is just a matter of figuring.

If I had a certain amount to figure and I assumed the wrong rate of interest, that is not going to affect the finances of my company nor change its condition.

Mr. Frink: It seems that there has been a pretty general misunderstanding all around on this proposition. What this committee has been engaged in trying to do is to make a yard-stick to make a more definite measure of relative value of structures, not to either create or designate as proper a method of financing renewals. But in getting our yard-stick shaped up, we ran across these various methods to provide for renewals, and it seemed to us that an investigation of them and an explanation of them to the convention was necessary in order to understand the basis of the conclusions that we have formulated.

It seems to me that practically the effect of the three methods, the replacement method, the capitalization method and the sinking fund method, is the same. To my mind, those things are practically alike. Mr. Sullivan says no concern on earth that he knows of provides for the replacement of structures by the capitalization method. You are all doing it, every one of you, as far as I know, except one concern. You are providing for replacements of structures by taking the money out of accumulated earnings, or else borrowing new money when the time comes. In order to get a sinking fund, you have got to put aside capital. Therefore, you have used the capitalization method.

Mr. Sullivan: I agree with everything that Mr. Frink has said, only that that applies to the sinking fund method, and not to the capitalization method. Renewals are charged to maintenance, but charging has nothing to do with it. The cost of replacements may be three or four times the amount of earnings.

Mr. Frink: If you set aside an amount of capital to draw interest to produce a certain annual sum for repairs, you are doing just exactly the same thing as if you had that capital in your business earning that money. There are two points that I want to speak of very briefly. One is the ultimate cost. It seems to me unquestionably that the ultimate cost of a structure is the measure of value of that structure to you. In the formulas the annual cost is given as to the ratio of the ultimate cost; therefore, in this particular case, the question of cost is a proper criterion, and that may be so in all cases. The committee is perfectly willing to concede that.

The other point is the sinking fund.

You will all agree with me that the popular conception of a sinking fund is a fund that is detached entirely from your capital. If that is true, necessarily a sinking fund must earn a lower rate of interest, because it is, I think, always true that the more secure an investment is, the more detached it is from ordinary business, the lower the return.

It has been the contention of the committee, and it is still their belief and conclusion, that any method used for the replacement of structures should keep, in the working capital of the company, all the money that is to be accumulated for a reserve, so that whatever interest you earn on your money will be devoted entirely to replacement. Of course, if you are so unfortunate as not to earn anything on the money, then the argument of the committee would fall to the ground; but we are assuming you can earn at least as much as capital is worth.

S. S. Roberts (consulting engineer): I spoke last year in support of this committee, and I wish to again speak in their support. I have used satisfactorily similar formulas to those proposed by the committee. The formulas are not new and untried. I agree thoroughly with the chairman, that these formulas have nothing to do with the methods of financing. They are simply means of comparing relative merits. I believe that the method this committee proposes is the best method for making comparison.

Mr. Sullivan: I have no objection to these formulas as such, and on the assumption on which they were worked out, I think they are admirable. On that assumption we will get correct results. I think the committee is entitled to the approval of the association for the care with which they have worked out this problem on a theoretical basis. The formula justifies itself, in so far as the assumptions on which it was worked out go, and if those assumptions are in accordance with the method of financing railway operations, then this is the proper formula to use; but if your particular railroad does not finance its operations, on the assumption on which this formula rests, then that formula is not a correct formula for you to use in advising your company as to the financial economics involved in the question of the expenditure of money. You must take this formula

or any other formula to the auditor of a railway company and have the auditor justify it before you can say that the results from the formula represent the financial results to the company.

(The motion for the adoption of the committee's conclusion was put to a vote and carried, and on a motion of Mr. Sullivan, Mr. Frink's motion to adopt the analysis on the capitalization method was amended to include also the fund method, and the comparison of the two.)

Mr. Frink: The next subject assigned to the committee was the use of lag screws in trestle construction. We believe that we have gotten sufficient information to justify a final report and conclusion. Our final report is shown in appendix C.

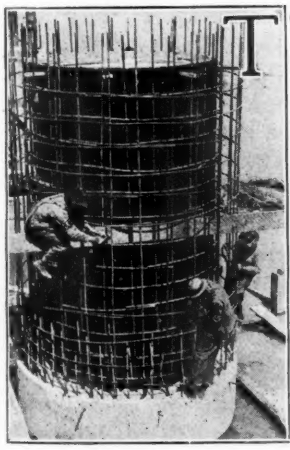
G. H. Gilbert (Sou. Ry.): The Queen & Crescent, for a period of six or eight years, at least, used bolts, and I regard that as much safer than the use of lag screws. Your ties may be split, and then you will have derailments under those conditions. A washer on the bottom of a tie will hold the bolt from falling out. I have seen many derailments through split ties, but only a very few bolts were out. Under the same conditions, I believe that you will find all of your lag screews will be torn out, therefore it does not seem to me that the lag screw is as safe to use.

J. C. Nelson (S. A. L.): I happened to be connected with the Queen & Crescent during this period that the gentleman mentions. One of our great difficulties at that time was to keep the nuts on the bolts, and I think I am safe in saying that after a year's period you can go to any trestle and pick up 80 or 90 per cent of the nuts. We adopted the plan of turning the bolts with the heads down, and putting in a slotted washer with a nail in it. Even with that, the bolt itself would turn and fall out, and we did not get any better results from that than we had with the other. I had never used lag screws until going to the Seaboard Air Line Railway in 1907. I found it in use there, and at first I was very skeptical about it, but I watched it for two years, and I found that there were fewer ties bunched on that railroad, where it had at that time something like 60-odd miles of wooden trestles, all of which used lag screws for their rails—I found fewer ties bunched than on any railroad I have known of or been connected with, and I have been watching them now for a little over 11 years.

(A motion that the conclusions be adopted and printed in the Manual was carried.)

The committee was dismissed with the thanks of the association.

# Report of Committee on Masonry



To THE CLASSIFICATION of Masonry on page 247 of the Manual should be added under the column headed "Dressing, Face or Surfaces," the different finishes of concrete, viz., spaded, rubbed, faced, unfaced, washed, acid treated, sand blast, tooled. This should be placed opposite "Bridge and Retaining Wall and Arch." Opposite "Culvert" "spaded" should be placed. On page 248 the definitions should be changed to agree with the definitions given in the adopted Specifications for Cement.

On page 249 under "Dressing" the definitions of concrete surface finishes as follows should be added:

SPADED FINISH.—Having surface formed by spading coarse aggregate back from the form into the mass concrete, so as to bring a surface of mortar next to the form.

RUBBED FINISH.—Having surface treated by rubbing with Carborundum or Cement Bricks, or Wooden Floats to remove all form marks and irregularities.

FACED SURFACES.—Having surface formed by placing a special aggregate not less than one inch next to the forms and contiguous with the body concrete.

UNFACED SURFACE.—Having surface formed by careful grading of the entire mass mixture and spading mixture to prevent voids leaving the coarse aggregate next to the forms.

WASHED OR SCRUBBED FINISH.—Having surface formed by rubbing or scrubbing to expose the aggregate.

ACID TREATED FINISH.—Having surface formed by dissolving cement with acid together with scrubbing to expose the aggregate.

SAND BLAST FINISH.—Having surface formed by the wearing effect of the sand blast.

TOOLED FINISH.—Having surface formed by dressing with bush hammer, crandall or other desired tool to a uniform depth and finish.

Page 252 should show after masonry specifications the new specifications for cement in accordance with the Supplement to the Manual, of July, 1917.

**Report on Cost and Method of Constructing Concrete Piles and Make Recommendations on How and Where to Be Used. Present Additional Typical Designs for Concrete Piles for Different Loading and Rules for Driving Under Various Conditions and Loading**

The committee, during the past year, has revised the definitions, specifications and information as to the manufacture and use of concrete piles which was submitted last year and presents with other data typical plans for their construction. The committee has not attempted to go into the details of design, as each condition of loading and of sub-soil demands special designs.

*Advantages of Concrete Piles*

In general, the more important advantages gained by the use of concrete piles are as follows:

(1) Foundations can be constructed above ground water level.

(2) As their size is not limited, piles of large diameter may be used in confined areas to reduce size of foundation and increase supports at points of greatest pressure.

(3) Concrete piles may be used in trestles where the height is such as to permit their use, making possible a permanent structure at a considerably less cost than the ordinary type of pier bridge.

(4) Concrete piles may be used to advantage for sheet piling for docks and wharves where lateral loads as well as vertical loads are to be resisted.

*Classification and Description of Concrete Piles*

Concrete piles may be properly divided into two classes:

(A) Pre-molded piles. Piles which are molded previous to driving.

(B) Molded-in-place piles. Piles which are molded in holes in the ground.

*Pre-Molded Piles*

There are many patented piles that are now available, many of which vary in some degree from the types submitted, each one having its particular advantages for some classes of work. The more common shapes used are the square and octagonal sections, depending upon the style of structure the piles are to carry. The square pile may best be used where a maximum top section is required to distribute the load. The octagonal pile, by reason of its comparative constant diametric section, presents the most suitable shape for general conditions. All shapes are used in the uniform section and in the tapered pile.

The uniform section pile should be used when the pile rests on solid rock or hardpan, or is driven through sand or other similar material which is subject to flow on account of future excavations or from other causes, tending to cause the piles to act as a column. The uniform section pile is more commonly used for all purposes on account of its greater strength for handling and lower cost of construction. The tapered pile possesses advantages over the uniform section pile when conditions require a close spacing, as its smaller volume causes less displacement of surrounding soil and piles. In general the tapered pile can be driven advantageously in all cases where the soil is clay or similar material, where skin friction will serve as a factor in the bearing power of the pile.

The typical designs for concrete piles, accompanying specifications for construction of concrete piles furnish, in the opinion of the committee, a sufficient variation to give information in regard to design of pre-molded piles that may be suitable for various classes of work. In general, piles which are designed to withstand handling are of sufficient strength for driving. The length, design and amount of steel reinforcement required depend upon the following factors:

(1) The load which the pile is to carry.

(2) The nature of the soil into which it is to be driven.

(3) Whether the pile acts as a single column or whether skin friction may be obtained.

(4) Forces to which the pile is subjecting in handling.

(5) The method employed in driving, including the use of the water jet.

The forms for concrete piles are generally supported on skids and are collapsible, the bottom being left under the piles until they are sufficiently seasoned to permit turning on the skids. The cost of constructing premolded piles depends upon the requirements as to design and on the manufacturing facilities.

The total cost of constructing and driving pre-molded concrete piles varies from 75 cents to $2 per linear foot, with an average price of about $1 per foot, varying with the conditions, length and number of piles made. Where the ordinary method of sheltered curing is employed, piles should be seasoned not less than 28 to 40 days before handling and driving, depending upon the amount of driving expected and the season of the year when the piles are made. The use of steam or other similar methods may be used to reduce the period of seasoning, or as a means of maintaining a uniform seasoning temperature during the winter season of the year.

## Specifications for Constructing Pre-Molded Concrete Piles

1. Piles shall be made in accordance with the dimensions shown on the drawings.

2. The workmanship and materials shall be in accordance with the Specifications for Plain and Reinforced Concrete and Steel Reinforcement of the American Railway Engineering Association, with the following modifications:

**Aggregates**

3. The coarse aggregate shall consist of material such as crushed stone or gravel varying in size from ¼ in. to ¾ in.

**Proportions**

4. The proportions of the concrete shall be one part cement, two parts fine aggregate and four parts coarse aggregate.

**Forms**

5. The forms shall be supported vertically or on skids sufficiently close to prevent sagging of forms.

**Reinforcement**

6. The longitudinal and transverse reinforcement shall be assembled and securely wired together in accordance with plan before being placed in form. Care shall be taken to maintain the proper position of reinforcing unit in the form until concrete has been placed and compacted.

**Freezing Weather**

7. In freezing weather concrete materials shall be stored, and mixing and placing shall be done in a building maintained at a temperature of not less than 40 deg. F. Piles shall not be exposed to a lower temperature for at least 10 days after forms are removed.

**Curing**

8. Where the ordinary method of sheltered curing is employed, piles shall be seasoned for a period of not less than three days before being moved on the skids and not less than twenty-eight days before handling and moving to the site or driving. No method of accelerated seasoning shall be used until approved by the engineer.

**Marking**

9. Each pile shall be stamped or marked with the date of its manufacture.

**Handling**

10. Piles shall be handled carefully, avoiding any dropping or heavy jarring while in horizontal positions.

*Explanatory Notes*

**Longitudinal Reinforcement**

Piles not exceeding 30 ft. in length are reinforced with 8 longitudinal bars, of which 4 are cut so as to stop at the beginning of the tapered point.

Piles exceeding 30 ft. in length are shown as having additional reinforcing bars placed midway between the longer bars throughout the middle third length of the pile in order to provide for handling.

## Specifications for Driving Pre-Molded Concrete Piles

1. Piles shall be protected while being driven with an approved cushion cap.

2. The driving or jetting of piles shall be governed by "Pile Driving—Principles of Practice," given in the Specifications for Workmanship for Pile and Frame Trestles in the Manual of the Association.

3. In driving, a steam hammer shall be used unless otherwise specified by the engineer. Where a drop ham-

mer is permitted, a heavy hammer with a short drop shall be used.

4. Any pile injured in driving or driven out of place shall be either replaced by a new pile or pulled and redriven, as the case may require.

5. On sloping ground, and where necessary, a suitable hole shall be dug at the location of each pile, sufficiently deep to hold the pile in proper position for the first few blows.

6. Before driving, the piles shall be carefully located and set to the line called for on the plan, and the pile driver leads held in proper position by means of guy lines. Unless otherwise called for on the plans, piles shall be driven as nearly as possible in a plumb position. Any pile out of plumb more than one-half inch per foot shall be pulled and redriven if so required by the engineer.

7. Reasonable efforts shall be made to drive the concrete piles to plan cut-off, the lengths of the piles having been determined by borings or test piles. Driving will be continued until this point is reached or until the following rate of penetration is secured, as specified by engineer. (Cases where driving is through soft soil to hard bottom or rock excepted.)

8. Piles shall be driven to a point requiring the following minimum number of blows for the last 2 in. of penetration of single-action steam hammer (weight of plunger 5,000 lb., drop 36 in.), or hammer of like mechanical effect.

(a) When piles are to carry 18 net tons—3 blows to last 2 in.

(b) When piles are to carry 25 net tons—4 blows to last 2 in.

(c) When piles are to carry 50 net tons—10 blows to last 2 in.

(d) When piles are to carry a load in excess of 50 tons, number of blows will be as specified by the engineer.

9. When driving is interrupted before final penetration is reached the record for degree of penetration shall not be taken until after at least 2 in. of penetration has been obtained. When necessary to obtain the required penetration, piles may be driven not to exceed 4 in. below plan cut-off.

### *Cutting-off Piles*

Where it is not possible to drive concrete piles to plan cut-off, the portion of the pile above this point shall be removed, but, unless otherwise specified, a variation of 4 in. will be allowed above the plan cut-off for the inequalities of the tops of the piles. All loose parts of the head of cut-off piles shall be removed. Where reinforcement has to be cut off, it shall be done by a hack saw or oxy-acetylene torch.

### "Molded-in-Place" Piles

"Molded-in-place" piles may be divided into three general groups, according to their method of construction. The successive steps in each method are briefly enumerated below:

(a) A collapsible steel mandrel encased with a spirally reinforced sheet-steel casing is driven to the required penetration. The steel mandrel is then withdrawn and the steel casing which is left in the ground as a form, is filled with concrete.

(b) A cylindrical casing with a protecting point is driven to the required penetration. The casing after being filled with wet concrete is removed, and the space left by the casing is allowed to fill with concrete, thus forming the pile.

(c) A cylindrical casing with a core as a protecting and driving point is driven to the required penetration. The core is removed. A charge of concrete is placed and the core is used as a rammer to compress the surrounding soil at the base, thus forming an enlarged base to the pile.

Under conditions where "molded-in-place" piles may be used, the main advantages over the pre-molded piles are as follows:

(1) The length of the pile need not be definitely predetermined on account of being able to vary the lengths in driving.

(2) Saving in labor and material on account of the length of each pile being determined before concrete is placed, thus saving cut-offs.

(3) The delay resulting from allowing sufficient time for piles to season before they are handled is eliminated.

(4) Entire omission of reinforcement against handling.

The "molded-in-place" piles, by the nature of their construction, are essentially foundation piles, and may not in all cases be a substitute for the pre-molded piles. In the use of "molded-in-place" piles it is necessary to consider the effects of vibration and soil movement due to the driving of adjacent piles. When the core of the pipe casing is driven for a given pile, it displaces and compresses the earth adjacent to the hole which is formed, and the elastic earth tends to relieve its stress by crowding back. Many rules have been formulated for driving these piles in order to protect the unseasoned concrete of piles previously placed. As the result of tests, each of the following rules have been adopted on various pieces of work:

(a) No concrete shall be deposited in any pile form until all driving is completed within a radius of 9 ft. center to center of the pile to be filled.

(b) The setting of the concrete in any pile must not, under any consideration, be disturbed by driving another pile or piles within a radius of less than 9 ft. from it center to center, after a minimum interval of three hours or before the expiration of seven days from the time the concrete was mixed with water for that pile. The contractor may, however, at his own option drive pile forms within the 9-ft. radius to a depth not more than 3 ft. from the total estimated penetration inside of the 3-hour limit, and before the expiration of the seven-day limit, complete the driving of those forms.

The requirements necessary vary with the plans and the soil encountered. The unseasoned concrete is more liable to damage on account of the driving of piles when soil is made up of thin, hard strata alternating with soft strata.

The above rules for driving of adjacent piles have been neglected in many cases, on account of the expense incurred in their operation and the lack of definite knowledge as to their necessity.

It should also be added that the construction of molded-in-place piles requires more careful supervision to secure good results on account of the manner in which concrete is deposited, and the surrounding conditions which preclude inspection of the pile after the concrete is all in place.

All "molded-in-place" piles are patented and are generally driven by companies either owning or controlling the patented features. The diameter and shape of the piles vary; tapered piles average an 8-in. tip and an 18-in. top diameter for a pile 25 ft. in length. The uniform section piles are circular and average 17 in. in diameter. No general specifications can be made for their construction, as each type of pile has its individual features demanding special methods of construction.

The cost will vary from 85 cents to $2 per linear foot,

with an average cost of $1, depending upon the number of piles driven and their lengths. Lengths of piles are always measured from cut-off to tip of pile. The expense of moving and setting up the special equipment necessary for this type makes them more economical on larger rather than smaller pieces of work.

Loading of piles may be calculated from the same data as that given for pre-molded piles.

## Typical Design of Foundations for Piers, Abutments, Retaining Walls and Arches in Various Soils and Depths of Water (Not Including Pneumatic Foundations)

There are a number of important elements entering into the design of foundations and on which the committee has found a large divergence of opinion, and it is on these points that the committee presents the following as its opinion of the best practice to be used in designing foundations:

(1) That for important structures wash borings as a means of determining character and bearing values of foundation soils are not generally reliable. That for important structures core borings give the most reliable data. The borings should in general be carried at least 10 ft. into rock, when encountered. Diamond, calyx or similar drills furnish cylindrical cores of all stratas of hard material. Soil, sand, clay and lighter materials will be brought to the surface similar to wash borings.

(2) That for important structures, where there is no reliable data, or where there is any question of the safe bearing value, soil bearing tests be made; the test loads being increased until settlement occurs or until twice the bearing load it is proposed to use in the design has been reached. That one-half the ultimate load thus found be used in designing the foundation except that ¾ of the ultimate load may be used for maximum toe pressures produced by tractive force or wind; provided, however, that the safe load thus found does not exceed the safe crushing value of the materials of the substructure.

(3) That pile bearing formulas based on the fall and weight of the hammer are not always a true index of the safe bearing value of the pile, but are of value in determining the extent to which driving is necessary in a soil of known resistance. That for important structures where data is lacking or where there is any question of the safe bearing value, load tests be made; the loading being increased until settlement occurs or until twice the load per pile it is proposed to use in the design is reached.

That one-half the ultimate load thus found be used in designing the foundations except that ¾ of the ultimate load may be used for the maximum pressures produced by tractive force and wind; provided, however, that the safe bearing value of the piling or materials of the substructure are not exceeded.

(4) That in general the buoyancy of structures in water be not considered as reducing the foundation load except in the case where water has free access to the base of the foundation or when calculating stability from overturning.

(5) That the loads to be considered in designing foundations are the total dead load of the substructure and superstructure, the live load, including an allowance for impact, tractive force, wind and ice pressure, and earth pressures in the case of retaining walls and abutments.

(6) That in general the cut-off of wood foundation piles in tidal waters shall not be above mean daily tides and shall not exceed 2 ft. above mean low water. That in general timber in foundations in tidal waters shall not be used above mean daily tides nor shall it be used at a greater elevation than 2 ft. above mean low water. That in general wood foundation piling and timbers be kept entirely below the probable lowest ground water level, except in the case of tidal waters as above noted. That in all waters where marine borers exist, no untreated timbers should be used above the permanent mud line of the bottom.

(7) That the spacing of wooden piling in foundations be not less than 2 ft. 6 in., center to center.

(8) That the bottom of foundations should be placed entirely below the line of frost action, the depth of foundation depending on the locality.

(9) That the calculations of foundation pressures be made in accordance with the rules and formula for the design of retaining walls published in the Supplement to the Manual, Vol. 19, No. 197, pp. 47-55.

## The Wisdom of the Use of Blast Furnace Slag in Reinforced Concrete Work, Taking Into Special Consideration Its Probable Duration

The use of slag as an aggregate in concrete covers a period of 20 years or more, but it is only within recent years that it has had extended use, particularly in reinforced concrete. Beginning with its utilization for the concrete structures of the steel companies the greatest development has been in the communities tributary to the steel mills. Large quantities of slag are used in building operation, particularly in Birmingham, Cleveland and Youngstown, Ohio. The use of slag in concrete is sanctioned by the building ordinances of Detroit, Cleveland, Chicago, Philadelphia and Youngstown. Probably the most general use has been at Cleveland, where a large number of reinforced concrete buildings have been constructed with slag as a coarse aggregate. Specific examples of concrete structures in which slag is used include the grade separation structures of the Seaboard Air Line at Birmingham, incolving 11,000 cu. yd.; the Rocky River Bridge at Rocky River, Ohio; subway structures of the Philadelphia Rapid Transit Company and the North Howard Street Bridge at Akron, Ohio. The last is an arch bridge nearly 800 ft. long with a roadway 190 ft. above the bed stream and required the use of 5,000 cu. yd. of concrete.

Numerous tests have been made of slag concrete which show conclusively that a properly selected slag when used as the coarse aggregate with a good quality of sand as the fine aggregate will produce a strong concrete. These tests brought to notice in recent years go to show that slag concretes are as strong as stone or gravel concretes containing the same quantity of cement, provided a properly selected material is used. The strength bears little relation to the weight of the slag used, the porous varieties producing concretes of fully as great strength as the dense materials for tests at 28 days. For greater ages the concretes made of denser slags show a greater increase in strength. Owing to the fact that slag is generally more porous than stone it is necessary to exercise care in proportioning to provide sufficient mortar to fill the voids in the particles as well as between them.

### *Soundness*

A more important question is that of the soundness of slag concrete. This question is raised by the fact that some slags slake or disintegrate upon exposure to the air and are entirely unsuitable for use as aggregate. It is common practice to allow the slag to weather for a number of months before removing from the bank. This results in a hardening or toughening of the stable slags

and permits the detection of those that disintegrate upon exposure to the atmosphere. A considerable difference of opinion and practice exists as to this seasoning, but good practice would seem to demand a period in the bank of six months to a year. However, it is a fact that some slags are used after only a few weeks' exposure with apparently satisfactory results.

The most discussed point in the use of slag as an aggregate in concrete arises from the presence of sulphur. It is contended that a lack of stability of the compounds of this element occurring would result in the eventual disintegration of the concrete and also that its presence would lead to the formation of sulphuric acid which would result in the corrosion of embedded steel. Sulphur usually occurs as a sulphide of calcium, a form in which it is inactive, but in the presence of water it is contended that sulphuric acid would result. On the other hand, slag concrete has been used extensively in foundation work and numerous examples are cited of anchor bolts and other embedded pieces of iron and steel which have been in close contact with slag concrete containing sulphur for many years without any sign of injury.

*Summary*

(1) The strength of concrete in which selected slag is used as the coarse aggregate is equal to that of a concrete made of stone if an equal amount of cement is used per volume of concrete.

(2) The extensive use of slag concrete over a period of years has demonstrated its permanence for buildings, retaining walls, bridges and foundations work where the structure is exposed to ordinary conditions.

(3) No data on water-tightness, or behavior when submerged, were obtained.

(4) No case has been brought to notice where embedded steel became corroded in a slag concrete.

(5) In general, slag concretes are superior to stone or gravel concretes where exposed to high temperatures.

(6) The user of slag for a concrete aggregate should satisfy himself as to suitability of the material tributary to his locality, from observation of the method of production and the service records of structures previously built.

## Designs and Recommended Specifications for Construction of Concrete Culvert Pipe

Plans and specifications of concrete pipe were obtained from all railroad companies known to have plans and specifications of their own, from firms manufacturing concrete pipe and from the highway departments of several states. The designs are of four types as to form and reinforcement:

1. Circular in cross-section with two concentric layers of reinforcement, one near the outside surface and the other near the inside surface of the pipe.
2. Circular in cross-section with one layer of reinforcement placed elliptically so as to pass continuously through all parts of the pipe that are subject to tension.
3. Oval in cross-section with one layer of circular reinforcement placed so as to pass continuously through all parts of the pipe that are subject to tension.
4. Circular in cross-section with one layer of concentric reinforcement.

As the points of greatest bending moments in the pipe are the segments crossed by the vertical and the horizontal diameters with the resulting tensile stress in the inner portion of the pipe for the vertical and in the outer portion for the horizontal moments, the fourth type of design does not provide reinforcement for the tensile stress from the horizontal moments and is, therefore, not recommended for use for culverts. Pipes reinforced as in types No. 2 and No. 3 should have the top plainly marked in order that the pipe may be placed so that the reinforcement is in the proper position to carry the tensile stresses.

In designing reinforced concrete culvert pipe the use of unit stresses per square inch of 700 lb. compression in the concrete and 16,000 lb. tension in the steel may be considered good practice, and to develop these stresses approximately 0.88 per cent of reinforcement is required. The following formulæ are proposed for the thickness of the pipe and the area of the reinforcement, in which:

$t$ = distance in inches from the center of the reinforcement to the compression face of the concrete.
$a$ = distance in inches from the center of the reinforcement to the tension face of the concrete.
$t^1 = t + a$ = total thickness of the pipe.
$A$ = area of reinforcement in square inches.
$d$ = mean diameter of the pipe in feet.
$w$ = weight per square foot of the load on the pipe in pounds.
$p$ = 0.83 per cent. of reinforcement.
$fs$ = 16,000 lbs. = unit tensile stress in the reinforcement.
$fc$ = 680 lbs. = unit compressive stress in the concrete.

(1) $t = 0.023d\sqrt{w}$ or
(2) $t = 0.03d\sqrt{w}$
(3) $A = 0.10t$
(4) $t^1 = t + a$

These formulæ are derived from those developed by Prof. A. N. Talbot from his experiments and tests of the strength of pipe published in Bulletin No. 22 of the Engineering Experiment Station of the University of Illinois.

In view of the possible lack of extreme care in bedding the pipe and in filling around it, the value of equation (2) for the value of "t" is recommended, viz.:

$$t = 0.03d\sqrt{w}$$

The load per square foot "w" will be the weight of the prism of earth above the pipe, the load from an engine and the load from impact. The weight of the earth will increase with the height of the fill while the load from the engine and from impact will decrease; the latter probably need not be considered except for low fills. It is evident also that the proportion of the weight of the prism of earth coming on the pipe decreases as the height increases. The committee has given considerable study to the problem, to find a value for the load per square foot that would be sufficient for general use, but have been unable to find enough data to determine this satisfactorily.

The desirability of one value for all heights of fill under ordinary conditions is very evident, and we ask that further investigation be made for that purpose.

## Specifications for the Construction of Reinforced Concrete Culvert Pipe

*Concrete Material*

**Cement**

1. The cement shall be Portland and shall meet the requirements of the Standard Specifications for Portland cement of the American Railway Engineering Association. Cement that has deteriorated or become damaged during transportation or storage shall not be used.

**Fine Aggregate**

2. The fine aggregate shall consist of sand or crushed stone, graded from fine to coarse, and passing when dry a screen having 4 meshes per linear inch. It shall preferably be of hard silicious material, clean, coarse and free from dust, soft particles, loam and vegetable or other foreign matter.

Not more than 20 per cent shall pass a sieve having 50 meshes per linear inch and not more than 6 per cent shall pass a sieve having 100 meshes per linear inch.

**Coarse Aggregate**

3. The coarse aggregate shall consist of crushed stone or gravel which is retained on a screen having 4

meshes per linear inch and shall not exceed ¾ in. in greatest dimension for pipe 4½ in. or less in thickness, or 1 in. in greatest dimension for pipe of thickness greater than 4½ in. The coarse aggregate shall be a gradation of sizes from the smallest to the largest particles, and shall be clean, hard, durable and free from all deleterious matter. Aggregates containing dust, soft or elongated particles shall not be used.

**Water**

4. The water shall be free from oil, acid, alkali and vegetable matter.

### *Steel Reinforcement*

5. The steel for reinforcement shall meet the requirements of the Standard Specifications for Steel Reinforcements of the American Railway Engineering Association.

### *Workmanship*

**Proportions**

6. The proportions of the materials for the concrete shall be: 1 part Portland cement, 2 parts fine aggregate, and 4 parts coarse aggregate.

**Measurement**

7. The unit of measure shall be a cubic foot. A bag containing not less than 94 lb. of cement shall be assumed to measure one cubic foot of cement. The fine and coarse aggregate shall be measured as loosely thrown into the measuring receptacle. The various ingredients, including the water, shall be measured separately, and by such methods as to invariably secure the proper proportions.

**Mixing**

8. The concrete materials shall be mixed to the desired consistency in a batch mixer of an approved type. The mixing shall continue for at least 2 min. after all the materials, including the water, are in the mixer.

**Consistency**

9. Sufficient water shall be used to produce a concrete of such consistency that it will flow around the reinforcement, but not enough to allow the coarse aggregate to separate from the mortar.

**Retempering**

10. Retempering of mortar or concrete, that is, remixing with water after it has partially set, will not be permitted.

**Placing Concrete**

11. The concrete shall be placed in layers so as to completely fill the entire space between the inner and the outer forms in one continuous operation; and shall be well spaded and compacted around the reinforcing metal, to obtain a concrete of maximum density, thoroughly bonded with the reinforcement, and smooth, dense watertight surfaces inside and outside of the pipe.

**Temperature**

12. No pipe shall be manufactured in a temperature below 40 deg. F. Both aggregates shall be heated if necessary to remove frost and frozen lumps.

**Forms**

13. The forms shall be steel or metal-lined, true to plan, substantial and unyielding. They shall be kept free from rust, carefully cleaned of all adhering concrete after each use, and well oiled or greased each time before the concrete is placed.

### *Design*

**Classes**

14. Reinforced concrete culvert shall be of the following classes or forms:

A—Circular in cross-section with 2 concentric layers of reinforcement.

B—Circular in cross-section with 1 layer of reinforcement placed elliptically.

C—Oval in cross-section with 1 circular layer of reinforcement.

In all classes the location of the reinforcement shall be so designed that it will receive and carry the tensile stresses.

**Thickness and Area Reinforcement**

15. The thickness of the pipe and the area of the reinforcement shall be based upon unit stresses of 700 lb. per square inch compression in the concrete and 16,000 lb. per square inch tension in the steel and 0.83 per cent. of reinforcement, and shall be determined by the following formulæ:

$$t^1 = t + a$$
$$t = 0.03d\sqrt{w}$$
$$A = 0.10t$$

In which: $t^1$ = total thickness of the pipe in inches.
$d$ = mean diameter of the pipe in feet.
$w$ = load per square foot on the pipe in pounds.
$a$ = distance from the center of the reinforcement to the tension face of the concrete.
$t$ = distance from the center of the reinforcement to the compression face of the concrete.
$A$ = area of the reinforcement in square inches.

"a" shall not be less than ¾ in. for pipe less than 4 in. thick, and not less than 1 in. for pipe of thickness greater than 4 in.

"w" shall be the weight of the earth fill, assumed at 130 lb. per cubic foot to which shall be added for the engine load an amount obtained by dividing 4500 lb. by one plus one-half the height of the fill above the pipe in feet. In no case shall "w" be less than 2000 lb.

### *Details of Construction*

**Reinforcement**

16. The reinforcement shall consist of transverse and longitudinal rods of the size and spacing required by the design; or of triangular wire mesh or similar wire mesh of the size and weight required. The transverse and longitudinal rods shall be securely wired together at their intersections with No. 16 gage soft steel wire.

When 2 layers of reinforcement are used they shall be connected together at proper intervals by tie struts so arranged that the two layers may be handled as one member.

The reinforcement shall be thoroughly cleaned of all rust and scales, accurately placed and rigidly secured against displacement during the placing of the concrete.

**Splicing Reinforcement**

17. All splices shall be made at points of minimum stress. The splices in wire mesh shall lap at least two spaces or not less than 8 in. Rods shall lap not less than 24 diameters and the laps shall be tightly wired with No. 16 gage soft steel wire.

**Joints**

18. The joints shall be of the bell and spigot type. Where the thickness of the pipe is sufficient the bell may have the same external diameter as the body of the pipe; where the thickness is not sufficient to permit this the end of the pipe shall be flared out to form the bell.

The reinforcement shall be extended into the bell and bent to its form; with rod reinforcement 2 transverse rods shall be placed in the bell and the longitudinal rods, bent if necessary to the form of the bell, shall be securely wired to these transverse rods.

The top of pipe with reinforcement placed as in Classes "B" and "C" shall be marked on both ends with the word "Top" in order to insure the proper placing of the pipe.

**Finish**

19. All pipe shall have a clean, smooth finish both inside and outside. All smoothing, trimming or cleaning shall be done immediately after the forms are removed.

**Curing**

20. The forms shall not be removed until the concrete has thoroughly hardened and will not be injured or the pipe deformed in handling; and in no event in less that 24 hrs. after the concrete is placed.

The pipe shall be kept moist by frequent sprinkling

with water for not less than 7 days, sheltered from the sun during hot weather, and allowed to cure for 28 days before shipping; and shall not be subject to full loading in less than 45 days after casting.

*Patents*

21. The contractor or manufacturer shall pay all royalties for the use of patented designs or devices or forms of construction, and shall protect the railroad company from all claims of infringements or liability for the use of such patents.

*Inspection*

22. All material and all processes of manufacture shall be subject to inspection and approval at all times. Free access shall be provided for all authorized inspectors to all parts of factories and plants in which the pipe or the materials for the same are made or prepared.

All facilities for the desired inspection of materials and workmanship shall be furnished free of charge by the contractor as requested. In general the cement and reinforcing material will be inspected at the factory or mill. The aggregates and process of manufacture will be inspected at the pipe plant.

At the time the forms are removed the inspector shall carefully examine each piece of pipe and shall stamp or print the date of manufacture on the bell end of each pipe accepted.

Pipe that is injured or develops imperfections while stored at the manufacturer's plant will be rejected, notwithstanding the inspector's previous acceptance. No defective pipe shall be loaded for shipment. All pipe shall be so loaded and braced that they will not be broken in transit.

## Suggestions for Future Work

1. Preparation of new specifications for plain and reinforced concrete and steel reinforcement.
2. An investigation of different methods of depositing concrete under water and disintegration of concrete and corrosion of reinforcing material in connection with use of concrete in sea water.
3. Preparation of specifications for slag concrete.

Committee: F. L. Thompson (I. C.), chairman; J. J. Yates (C. R. R. of N. J.), vice-chairman); R. Armour (G. T.), John C. Beye (A. T. & S. F.), G. E. Boyd (D. L. & W.), H. A. Cassil (P. M.), C. S. Coe (F. E. C.), T. L. Condron (Cons. Engr.), J. K. Conner (L. E. & W.), C. S. Davis (P. L.), J. L. Harrington (Cons. Engr.), W. K. Hatt (Purdue Univ.), L. J. Hotchkiss (Cons. Engr.), Richard L. Humphrey (Cons. Engr.), Noah Johnson (Wab.), M. S. Ketchum (Univ. of Colo.), W. M. Kinney, W. S. Lacher (Ry. Age.), A. E. Owen (C. R. R. of N. J.), W. M. Ray (B. & O.), C. P. Richardson (C. R. I. & P.), G. H. Scribner, Jr. (Cons. Engr.), F. P. Sisson (G. T.), J. E. Smith (Univ. of Ill.), Job Tuthill (P. M.), B. A. Underwood (S. N. E.).

## Discussion

F. L. Thompson (Chairman): I will take up the subjects as assigned to the committee.

The changes suggested in connection with the revision of the Manual are only changes that are necessary to make it conform to specifications heretofore adopted by the association.

The President: As this appears to be a matter of diction and uniformity, unless there is some objection these revisions will be approved and printed in the supplement to the Manual.

Mr. Thompson then read appendix B and said: Last year these specifications were temporarily adopted by the convention and later the question came up of submitting these specifications with plans and the committee was instructed to resubmit them this year, with a set of plans. That has been done.

H. S. Jacoby (Cornell Univ.): Last year the report of the committee used the term "cast-in-place" for class B, and I do not recall that a single voice was raised against its appropriateness, I therefore move that the line be amended to read: (B) Cast-in-place piles. Piles which are constructed in holes in the ground.

The President: The committee will accept that suggestion.

Mr. Thompson: I move that the specifications for constructing pre-molded concrete piles be accepted by the convention and printed in the Manual.

The President: Unless there is objection, the motion made by Mr. Thompson will stand approved.

Mr. Thompson: The next thing is the specifications for driving pre-molded concrete piles. These specifications have been gone over and revised in accordance with the suggestions made on the floor last year, and are now recommended for adoption by the convention and insertion in the Manual. I move that they be adopted and printed in the Manual.

A. A. Robinson (Santa Fe): I want to urge that the committee, in submitting these specifications either remove or remodel paragraph 8. I do not believe we are entitled to give any such set of rules for the last two inches of penetration of the piles that there shall be used a single-action steam hammer of 5,000 lb., drop 36 in., or a hammer of like mechanical effect. I do not think as an association we want to go on record as saying that they shall be driven in a certain manner, if they are going to have 50 tons load or more, and prescribe that in the case of 50 tons there shall be 10 blows to the last 10 in.

The President: The committee will accept the suggestion, leaving the paragraph out.

Mr. Ford: I think the committee was right in the way it prepared this paragraph. I hope if the paragraph is dropped that the committee will ultimately bring in something as a guide on the load for concrete piles. The situation is different from wooden piles.

Mr. Robinson: I move that the paragraph be omitted and passed back to the committee, with the suggestion that they investigate that phase of the matter further and report later on.

The President: The committee will take cognizance of that.

C. P. Richardson (Rock Island): There is a misunderstanding here. Paragraph 8 was written as a continuation of paragraph 7, as an alternative method.

Mr. Robinson: Paragraph 8 is misleading and not clear and it should be left out.

The President: The committee will accept the recommendation and will look after it.

I. L. Simmons (Rock Island): Paragraph 3 does not seem to be clear in the last part, which says: "Where a drop hammer is permitted, a heavy hammer with a short drop shall be used." Would it not define what we mean if we said: "and a short drop used?"

The President: The committee will accept that.

(The motion that paragraphs 1 to 9 be approved, with the exception of paragraph 8, and be included in the Manual, was carried.)

Mr. Thompson: With relation to the matter on "molded-in-place piles," this is submitted as information to be printed in the Proceedings.

(Mr. Thompson then referred to the matter in appendix C, reading a part of the beginning.)

Mr. Thompson: This subject has been before the con-

vention for the past three years, and it is the recommendation of the committee that the matter on pages 731-2-3 be accepted as information and printed in the Proceedings.

Mr. Jacoby: I move that the paragraph marked (3) and the following one be amended to read as follows: "(3) That the computed bearing value of a pile given by a formula based upon the fall and weight of the hammer is not always a true index of its actual bearing power, but is of value in determining the extent to which driving is necessary in a soil of known resistance.

The bearing value of a pile computed by means of a formula measures the resistance of the pile immediately after driving ceases. Therefore, in the case of soft soils, in which the frictional resistance of a pile increases materially after a period of rest, a test should be made with the hammer after such period of rest, in order that the computed bearing value may be a fair measure of the actual bearing power of the pile when supporting the structure. Formulas for the bearing power of a pile are not applicable to piles driven through very soft soil to rock or other hard material, since they act like columns under those conditions.

The President: The committee will accept that.

Mr. Jacoby: There is one more point that I would like to make and that is, should not the word "static" be inserted in the 3rd line from the bottom of p. 732 before the word "load tests?"

Mr. Thompson: Yes, that is right. In appendix D is given the report, "The wisdom of the use of blast furnace slag in reinforced concrete work, taking into especial consideration its probable duration." This matter is submitted as information.

The President: That will be accepted.

(The committee was excused with the thanks of the association.)

# Report of Committee on Roadway

A CIRCULAR LETTER was addressed to representatives of about 50 of the larger roads asking for information concerning the practice followed in draining the roadway through station grounds. About 20 replies were received.

After consideration and discussion of the above replies the following conclusions were drafted and submitted for approval:

1. The drainage of the roadway through stations and yards should be treated in accordance with local conditions.
2. Surface water should be carried off the roadbed into drains as quickly as possible.
3. Items influencing the mode of procedure are: Soil condition, the contour of adjacent grounds, the grade of tracks, the number of tracks, the amount of rainfall, etc.
4. Surface water should be taken care of first by open ditches as much as possible, where they will not interfere with the work of employees or the safety of passengers.
5. Where the subgrade is of such a nature that it will absorb water and not retain it, a sub-ballast of engine cinders should be used, the surface of which should not be allowed to become foul, but kept open so that water will penetrate the subgrade through the cinder. Where the subgrade will hold water, special effort should be made to carry it away from the subgrade by means of drains.
6. Tracks in yards should be so constructed where practicable that tracks adjacent to main lines will be about two inches below them and each succeeding track stepped down to suit the normal trend of drainage, thus providing drainage laterally as well as longitudinally.
7. Cross-drains of cast iron pipe, with catch basins between tracks, should be placed where necessary.
8. If the subsoil is of such a nature that it retains water and becomes saturated therewith, place bell and vitrified drain pipe with open joints between tracks and about four feet below base of rail, using special care to put them below frost and deep enough to get below the movement of the soil; these pipes running into cross-drains leading to natural drainage.
9. If the subsoil is silty or of such consistency as to fill up the pipe quickly, a wide ditch should be dug, preferably between tracks, and filled with large stone, having pipes leading off from it to the natural drainage.
10. At station platforms a subdrain of iron pipe, with catch basins at frequent intervals, should be laid alongside the curbing, or bell end vitrified pipe may be laid between tracks a sufficient depth to be below frost and movement of the soil. These drains to be connected by means of side drains to natural ditches, or in cuts to bell end vitrified subdrain laid in the ditch line.

### Recommendations for Next Year's Work

The committee recommended that all subjects assigned for consideration this year, except the one reported on above, be reassigned for next year's work.

Committee: W. M. Dawley (Erie), chairman; J. A. Spielmann (B. & O.), vice-chairman; J. R. W. Ambrose (T. T.), H. E. Astley (N. Y. N. H. & H.), C. W. Brown (L. & N. E.), S. P. Brown, B. M. Cheney (C. B. & Q.), C. W. Cochran (C. C. C. & St. L.), W. C. Curd, Paul Didier (B. & O.), S. B. Fisher (M. K. & T.), W. C. Kegler (C. C. C. & St. L.), F. Ringer (M. K. & T.), H. W. McLeod (C. P.), C. M. McVay (K. & M.), F. M. Patterson (I. C.), W. H. Petersen (C. R. I. & P.), P. Petri (B. & O.), W. F. Purdy (P. & W. Va.), R. A. Rutledge (A. T. & S. F.), W. H. Sellew (M. C.), J. M. Sills (St. L.-S. F.), G. R. Talcott (A. T. & S. F.), W. P. Wiltsee (N. & W.).

### Discussion

J. A. Spielmann (Vice Chairman): Our committee was assigned to subjects as found on page 403. We are only able to report on No. 6. In regard to No. 6 we sent out inquiries to 50 of the principal railroads in the country and received 20 replies.

(Mr. Spielmann then read the conclusions).

C. E. Lindsay (N. Y. C.): In number 7, I approve of the conclusion generally, but I think it ought not to be confined to cast iron pipe. If the committee would omit the words "cast iron pipe," the conclusion would be just as clear and less restricted. The same criticism will apply to No. 10, where they specify iron pipe.

The President: The committee will accept that suggestion.

C. W. Baldridge (Santa Fe): In regard to conclusion No. 8, it seems to me that the committee should make a little wider provision there for cases where it is not feasible to place the drain 4 ft. deep. In such cases it might be advantageous to use a drain composed of a ditch filled with rock or something of that nature.

Mr. Spielmann: In this we state about 4 ft., we do not specify exact depth, but it is well to get it below the frost line.

Mr. Baldridge: It is not the depth I object to particularly, but frequently, if you lay pipe that is not deep enough below the surface of the ground it will be broken in the winter time by frost, and in that case it might be better to use some other kind of drain than pipe drain.

W. P. Wiltsee (N. & W.): I believe we can get around this if we would change the wording, Place bell and vitrified drain pipe with open joints, or other drains between tracks, and cut out; And about four feet below base of rail."

Earl Stimson (B. & O.): I think that it is essential that mention be made as to the depth the vitrified pipe drain be placed. I believe the paragraph as it is covers the situation very well, and that we ought not to say something and then modify it so it really does not mean anything, or becomes very indefinite. I would suggest that the committee stand pat on this section.

The President: The necessity for putting in drains is evidently where we disagree, on the kind of drain and the depth. That is controlled by local conditions to such a great extent that I am afraid it will be hard to get a convention of men from so many different parts of the country to agree on a depth. We would have to put our pipe 8 ft. below the surface to keep away from frost.

Mr. Spielmann: Your committee now suggests that this clause read: "If the subsoil is of such a nature that it retains water, and becomes saturated therewith, place bell and vitrified drain pipe or other drains with open joints between tracks," leaving out the words "and about four feet below base of rail"; "using special care to put them below frost, and deep enough to get below the movement of the soil."

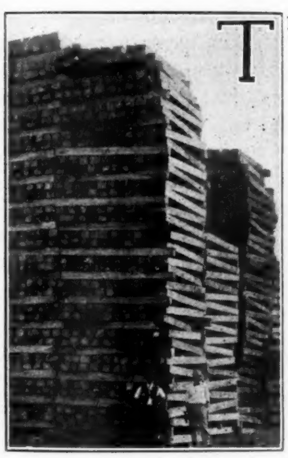
The President: If there is no further discussion, No. 8 will stand as the committee has amended it.

(Mr. Spielmann read paragraphs 9 and 10, leaving out the words "of iron pipe" in the first line.

The President: If there are no objections, the conclusions will be adopted and printed in the Manual as reported by the committee.

(The committee was dismissed with the thanks of the Association.)

# Report of Committee on Ties



THE COMMITTEE recommended that forms M. W. 301, 302, 303 and 304 be withdrawn from the Manual. The membership lines were asked as to their use of these forms and 100 replies, representing 232,026 miles, were received. Not a single road is using them and but 12, representing approximately 10,521 miles, contemplate doing so.

### Methods in Use by Various Railways for Controlling Tie Renewals

The committee submitted as information a report on the methods in use by various roads to control tie renewals. The following questions were sent to all the principal railroads, represented in the Association:

1. Who originates the data on which the estimates of tie renewals are based?
2. Are these estimates based on
   (a) Detailed inspection of the entire track, or,
   (b) Detailed inspection of portions of the track, or,
   (c) Tie renewal statistics, or,
   (d) Otherwise?
3. Are these estimates checked independently in the field, in whole or in part?
4. By whom are these estimates revised before approval?
5. Are individual ties designated to be renewed, or is the estimate merely to determine the number of ties required for renewals?
6. What latitude, if any, is allowed the Section Foreman in deviating from the approved inspection?
7. What check is made of the Section Foreman's work?
8. Please submit any general instructions you may have covering tie renewals.

Replies were received from 100 railroads, with an aggregate mileage of 223,000. A summary of these replies is appended to this report.

| | Per Cent. of Total Number of Roads Reporting | Per Cent. of Total Mileage of Roads Reporting |
|---|---|---|
| Renewals based primarily on detail inspection of track | 89 | 92 |
| Renewals based partly or exclusively on tie renewal statistics | 16 | 14 |
| Renewals based exclusively on tie renewal statistics | 9 | 4 |
| Detail inspection made by section foremen | 58 | 54 |
| Detail inspection made by others than section foremen | 33 | 42 |
| Individual ties for renewal designated by spots or otherwise | 38 | 52 |
| Individual ties for renewal not designated | 62 | 48 |
| Section foremen limited in renewals to ties authorized except such additional as are required for safety | 67 | 67 |
| Section foremen not limited in renewals to those authorized | 33 | 33 |
| Work of making renewals checked by roadmaster (or supervisor) | 77 | 74 |
| Work of making renewals checked by others than roadmaster (or supervisor) | 33 | 19 |

The committee wishes to point out that the method in most general use is not necessarily the best, and that methods may very properly differ on different roads, depending upon the organization, physical conditions, and other factors. A study of the replies shows that all roads depend largely upon an inspection of ties removed for the purpose of checking renewals. A majority of the roads place the principal responsibility for renewals upon the section foreman, while a considerable number place this responsibility primarily upon an inspector working independently of the section foreman. The other variations in method represent individual opinions as to the best method of checking the original source of information. This checking takes the form of an independent review of the original check in the field and also checking same against statistics.

### Report on Trials of Substitute Ties

The information furnished by the various railroads using substitute ties was abstracted as usual, and the results to date were shown on a tabulated statement. This statement is intended to include all installations on steam railroads in America reported to the Association, and is

thought to cover practically all substitute ties used so far in this country.

### Conclusions

(1) The committee recommends that forms Nos. M. W. 300, 301, 302, 303, 304 be withdrawn from the Manual.

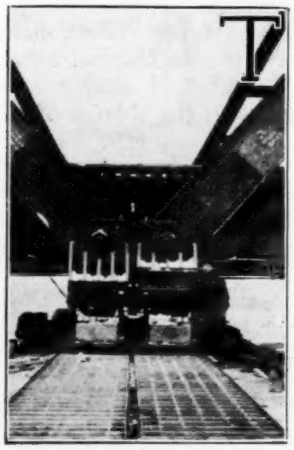
(2) That the report as to methods in use by various railroads for controlling tie renewals be received as information.

(3) That the report on substitute ties be received as information.

Committee: F. R. Layng (B. & L. E.), chairman; H. S. Wilgus (P. S. & N.), vice-chairman; C. C. Albright (Purdue Univ.), W. C. Baisinger (A. T. & S. F.), M. S. Blaiklock (G. T.), Theo. Bloecher (B. & O.), F. Boardman (N. Y. C.), W. J. Burton (M. P.), W. A. Clark (D. & I. R.), S. B. Clement (T. & N. O.), E. L. Crugar (I. C.), L. A. Downs (I. C.), G. F. Hand (N. Y. N. H. & H.), L. C. Hartley (C. & E. I.), E. D. Jackson (B. & O.), J. B. Myers (B & O.), A. J. Neafie (D. L. & W.), R. R. Paine (N. P.), G. P. Palmer (B. & O. C. T.), Louis Yager (N. P.).

(The report was accepted without discussion and the committee was dismissed with the thanks of the association.)

# Report of Committee on Iron and Steel Structures



THE COMMITTEE HAS undertaken a revision of the subject-matter of the Association's General Specifications for Steel Railway Bridges which were adopted as part of the committee's report to the 1906 convention. There has been no substantial revision of them since. In this work, it is expected to co-operate with a corresponding committee of the Canadian Society of Civil Engineers, which has in progress a revision of that society's specifications. Incidental to the revision of the specifications, there will have to be a revision of the rules and unit stresses for the capacity rating of existing bridges.

The committee is investigating the use of plastic compounds for the protection of steel work exposed to the blast action from locomotive stacks. The committee this year has investigated the Schoop metal spraying process for the protection of iron and steel from corrosion. It was found that laboratory tests made by certain railroads showed unsatisfactory results. In all cases it was reported that the coatings were pervious to water. Where bronze, lead and aluminum coatings were exposed to brine, the bronze and lead coatings were practically destroyed after a few weeks' exposure; the aluminum coating was in good condition, but was raised off the plate, showing the action of rust beneath the coating. It is concluded from information obtainable to date that the Schoop metal spraying process does not afford satisfactory protection from corrosion.

The committee submitted detailed Specifications for Movable Bridges and recommended that they be printed in the Proceedings as information. The purpose of this recommendation was to make the specifications available for use, and to incite constructive criticism, with the expectation that the specifications may be adopted in revised and satisfactory form for inclusion in the Manual a year or two later.

### Impact Tests on the Electrified Section of the C. M. & St. P. in 1917

The question of impact under electric locomotives has been thoroughly studied by the committee, and during the summer of 1917 some important tests were made on bridges on the electrified section of the Chicago, Milwaukee & St. Paul in Montana. The tests on the Norfolk & Western made in 1916 did not include spans exceeding 90 ft. in length, and the speeds available did not exceed about 29 miles per hour. Those tests, therefore, while of very considerable value, did not have sufficient range to be as conclusive as might be desired. The results obtained were very satisfactory, so far as they went, and tended strongly to confirm the opinion previously expressed that impact under well-balanced electric locomotives would be very small. The value of the results of those tests was very considerably enhanced by making use on the same structure of two types of steam locomotives; the consolidation type and the Mallet type. The very great difference between the results obtained with the steam locomotives and with the electric locomotives, especially on the longer spans, was very significant as tending to show the relatively small impact from electric locomotives. However, the limited range of span length and the limited speed made it very desirable to continue the tests if possible on longer spans and at higher speeds. The very best conditions for such tests were to be obtained on the electrified lines of the C. M. & St. P. in Montana, and a request by the committee for the necessary facilities was promptly acceded to by this company.

#### *Character of Structures Tested*

The structures tested consisted of the following types and span lengths:

FIRST CROSSING OF MISSOULA RIVER NEAR MISSOULA, MONT.
- 60-ft. through girder.
- 80-ft. through girder.
- 100-ft. riveted pony truss.

SECOND CROSSING OF MISSOULA RIVER NEAR CYR, MONT.
- 210-ft. deck truss.

THIRD CROSSING OF MISSOULA RIVER NEAR CYR, MONT.
- 240-ft. deck truss.

VIADUCT NEAR SALTESE, MONT.
- 62-ft. and 46½-ft. span lengths.

The test load consisted of an electric locomotive composed of two units, followed by a sufficient number of loaded cars to cover the structure. The locomotive had its motors geared to the driving-wheel axles, no side rods being used in this type. All rotating parts are presumed to be balanced, so that any impact effect would be due to such causes as roughness of wheels and track and deflection of structure.

The apparatus used in these tests was the same as that used in previous tests made by the committee. In addition to this apparatus, the committee made use, to a small extent, of certain extensometers employed by Prof. A. N. Talbot in the track experiments which he is conducting on behalf of the joint committee established for the study of track stresses. These extensometers record directly, without multiplication, the strains in the members to which they are attached. These instruments were used on a floor beam and on a short stringer. The re-

sults obtained on the floor beam indicated small impact, and tended to confirm the results obtained by the other type of extensometer which was applied to another beam of the same bridge. The results from the stringer indicated considerable impact, but many more observations would be necessary and much more experience with this type of apparatus before reliable results on the short spans could be secured. It is hoped that this field of experimentation can be adequately covered at some future time.

The tests were made in the same general manner as those previously reported, namely, the special test train was run over the structure a considerable number of times at various rates of speed. Movements were made at low speeds of 8 to 12 miles per hour so as to secure readings not affected by impact. These readings were considered to represent static stresses, and the excess of stress resulting from movements at higher speeds was considered to represent the impact effect. Speeds were readily obtained up to about 60 miles per hour and above. No tests were made with steam locomotives. It was thought the the very numerous experiments heretofore made with steam locomotives on structures of the kind herein described were sufficient to furnish a basis of comparison. The results of these tests, therefore, may be compared with the general results of those heretofore presented.

In general, the impact effects were in most cases very small, and particularly so in the long truss spans. The relatively large impact of 23 per cent in the top flange of the pony truss was probably due more to lateral movement than to vertical vibration. In the 60-ft. girder, instrumental vibration for speeds greater than about 50 miles per hour made the records valueless, but the results obtained for speeds below 50 miles per hour indicate that there was very little impact stress in the structure. The deflectometer readings are reliable.

### *Conclusions*

From the results of the tests on the electrified section of the Chicago, Milwaukee & St. Paul, the tests made in 1916 on the Norfolk & Western, and the few tests made in 1909 at Schenectady, New York, it would appear to be fairly well established that the impact effect from electric locomotives is very much less than from steam locomotives of the usual type. Comparing results obtained in these tests with the results from steam locomotives, it would appear that the impact from electric locomotives on structures exceeding, say, 25 ft. span length, is not more than one-third of the impact produced by steam locomotives.

## Column Tests

The program of column tests to be made by the Bureau of Standards for this Association was described fully in Vol. 16, p. 636. Of the eight column sections which it was originally decided to have tested, only Column No. 1 of Series No. 1, consisting of two channels with flanges turned in, has been touched so far.

Complete reports of the tests of the first eighteen columns tested already have been published. (Vol. 14, page 96; Vol. 15, page 435; Vol. 16, page 636, and inset at back of Volume, and Bulletin No. 173 for January, 1915.)

The present report covers tests of 24 columns made during 1916 by the Bureau of Standards under the direction of Dr. S. W. Stratton. These columns are variations of Column No. 1, Series No. 1; the same general dimensions, area of cross-section, and slenderness ratios are used, the variations consisting of (1) changes in size of rivets and lacing bars; (2) the leaving off of wing and base plates; (3) the substitution of batten plates for lacing with varying distances between the batten plates.

The Bureau of Standards intended to supplement these tests by a series of compression tests of short specimens, cut from the channels of the columns, which tests were intended to bring out the reason why the columns made of thick material always fail at lower unit stresses than those made of thin material. It was hoped that these short compression tests could have been made during 1917, and, in fact, many of these tests have actually been made, but, owing to stress of other business, the Bureau has been unable to complete the series and to furnish the committee with reports of the results. However, it may be stated that the short specimen tests show that, in compression, the thin material has a higher elastic strength than the thick material, although the original tensile specimen tests on which the material was accepted, gave practically identical results as regards the elastic limit in tension for the thick and the thin material. While the specimen tensile tests, in all cases, gave results reasonably close to the prescribed limits of 37,000 to 39,000 lb. per sq. in., the short compressive tests showed yield points varying from below 30,000 lb. per sq. in. to above 41,000 lb. per sq. in.

This series of column tests proves, as have all the previous ones both for this Association and for the American Society of Civil Engineers, that the columns built of thin material almost invariably show higher unit stresses at failure than the similar columns built of thick material. The series also seems to show that, with lacing bars and rivets somewhat larger than standard practice calls for, the column will show additional strength.

As regards the substitution of batten plates instead of lacing bars, this series of tests shows conclusively that, in order to develop the full strength of the column, batten plates should not be used. It also shows that, where the distance from center to center of outer rivets on adjacent battens is fixed so that the $l/r$ distance for the individual channel is about the same as that for the column considered as a whole, the column is weaker than when this distance is reduced. In all cases, the columns with battens failed at an ultimate strength from 6,000 to 9,000 lb. per sq. in. less than the corresponding column with lacing, and, in one case, the heavy section with 120 $l/r$, as much as 15,000 lb. per sq. in. less.

In all cases, the length for computing the slenderness ratio of the column was taken as the entire length of the column, or the length between base plates, where base plates were used. When failure is emphasized by the complete visible destruction of the column, it usually becomes quite apparent that points of inflection occur not far from the ends of the column. This is less noticeable in the batten-plated columns, where the method of failure is usually by sudden bending at the batten plates.

### *Conclusions*

The conclusions that seem warranted from the tests so far made in the proposed series are:

(1) Columns in which batten plates are substituted for lacing bars will not develop the full strength of the section and should not be used.

(2) The specimen tensile tests on which material is ordered and accepted afford no proper criterion for the strength of a column.

(3) A column designed so that it fails as a whole and not by reason of local weakness will have an ultimate strength of which the compressive yield point of the

material of which it is made up is an index, since the higher this yield point is, the stronger will be the column.

### Specifications for Bronze Bearing Metals for Turntables and Movable Railroad Bridges

1. Phosphor bronze shall be a homogeneous alloy of crystalline structure. It shall be made from new metals, except that scrap of known composition produced by the foundry at which the bronze is cast may be used. It shall not contain sulphur. The phosphorus shall be introduced in the form of phosphor-tin or phosphor-copper. Castings shall be sound, clean, and free from blowholes, porous places, cracks and other defects.

2. The alloy shall be cast into ingots and allowed to cool, and the castings shall be poured from the remelted ingots. Care shall be exercised that the metal is not overheated and that the temperature at pouring and the conditions of cooling are such as will be most likely to secure dense castings.

3. There shall be four grades:

*Grade A* is to be used for contact with hardened steel discs under pressures exceeding 1,500 lb. per sq. in., such as are used in turntables and center-bearing swing bridges.

*Grade B* is to be used for contact with soft steel at low speeds under pressures not exceeding 1,500 lb. per sq. in., such as trunnions and journals of bascule and lift bridges.

*Grade C* is to be used for ordinary machinery bearings.

*Grade D* is to be used for gears, worm wheels, nuts, and similar parts which are subjected to other than compressive stresses.

4. The chemical and physical qualities shall conform with the requirements in the table following:

**Chemical and Physical Qualities**

| | GRADE | | | |
|---|---|---|---|---|
| | A | B | C | D * |
| Alloy of | Copper and Tin | Copper and Tin | Copper, Tin and Lead | Copper, Tin and Zinc |
| Copper per cent | ......... | ......... | 82 max. | 89 max. |
| Tin per cent | 20 max. | 17 max. | 11 max. | 11 max. |
| Lead per cent | ......... | ......... | 11 max. | ......... |
| Zinc per cent | ......... | ......... | ......... | 2.25 max. |
| Phosphorus per cent | 1.0 max.<br>......... | 1.0 max.<br>......... | 1.0 max.<br>0.7 min. | 0.25 max.<br>......... |
| Other elements per cent | 0.5 max. | 0.5 max. | 0.5 max. | 0.5 max. |
| Elastic limit in compression, pounds per square inch | 24,000 min. | 18,000 min. | ......... | ......... |
| Permanent set under 160,000 pounds | .06 min.<br>.10 max. | .10 min.<br>.20 max. | ......... | ......... |
| Permanent set under 50,000 pounds | To be recorded | To be recorded | To be recorded | To be recorded |
| Yield point in tension, pounds per square inch | ......... | ......... | ......... | To be recorded |
| Ultimate strength in tension, pounds per square inch | ......... | ......... | ......... | 33,000 min. |
| Elongation in 2 in. per cent | ......... | ......... | ......... | 14 min. |

5. The chemical analysis of each heat shall be furnished.

6. Test specimens shall be made from coupons which are a part of the casting and which have been fed and cooled under the same conditions as the casting.

7. Compression test specimens shall be cylinders one inch high and of one square inch area. The elastic limit in compression shall be the load which gives a permanent set of 0.001 in.

8. Tension test specimens shall be turned from a coupon not less than one inch in diameter to the form shown in Fig. 2 of the American Railway Engineering Association, General Specifications for Steel Railway Bridges. The diameter of the turned specimen shall be one-half inch.

9. At least one compression test shall be made from each melt for grades A, B, and C; and one compression and one tension test for grade D. For castings weighing over 100 lb. finished the prescribed tests shall be made for each casting.

10. The hardness of the finished castings shall be tested by the Brinell ball method and a record of the test furnished. The ball shall be of hardened steel 10 mm. in diameter. The load shall be 500 kg. and shall be applied for 30 seconds to a finished plane surface. At least two hardness tests shall be made upon each heat. A test shall be made on each trunnion bearing and each disc.

Cracks or other evidence of excessive brittleness in compression test specimens after load may be cause for rejection.

### Recommendations

The committee recommended:

(1) That the conclusion regarding methods of protection of iron and steel structures against corrosion be approved.

(2) That the Specifications for Movable Bridges be received as information and published in the Proceedings, with a view of revising and adopting them for inclusion in the Manual a year hence.

(3) That the report on impact tests be received as information and published in the Proceedings.

(4) That the report on Column Tests be received as information and that the conclusions therein be approved for publication in the Manual.

(5) That the Specifications for Bronze Bearing Metals for Turntables and Movable Railroad Bridges be approved for publication in the Manual.

*Suggestions for Future Work*

1. Examination of the subject-matter in the Manual and definite recommendations for changes.

(a) Revise the General Specifications for Steel Railway Bridges.

(b) Revise the rules and unit stresses for classifying and rating the capacity of existing bridges.

2. Methods of Protection of Iron and Steel Structures against Corrosion.

Report upon the use of plastic compounds for the protection of steel work exposed to the blast action from locomotive stacks.

3. Relative Economy of Various Types of Movable Bridges.

Revise the Specifications for Movable Bridges and report them for adoption.

4. Secondary Stresses and Impact.

(a) Report definite principles for design to reduce secondary stresses and rules for computing or allowing for them.

(b) Study and draw conclusions from records of impact tests.

(c) Continue impact tests and stress measurements as funds may be available.

5. Column Tests.

Continue with program of column tests as far as the work of the Bureau of Standards will permit.

6. Design, Length, and Operation of Turntables.

(a) Report specifications for the design of turntables and turntable pits.

(b) Report specifications for steel for turntable roller and disc bearings.

7. Ballast Floor Bridges and Methods in Use for Waterproofing.

Report principles for detailed design of flashing, drainage, and reinforcement for waterproofing purposes.

8. Track Scales.

Collaborate with the committee on Yards and Terminals in the design of track scale superstructures.

Committee: O. E. Selby (C. C. C. & St. L.), chairman; F. E. Turneaure (Univ. of Wis.), vice-chairman; J. A. Bohland (G. N.), W. S. Bouton (B. & O.), A. W. Carpenter (N. Y. C.), Charles Chandler (I. C. ), J. E. Crawford (N. & W.), F. O. Dufour, W. R. Edwards (I. C. C.), A. C. Irwin (Port. Cem. Assoc.), J. M. Johnson (I. C.), B. R. Leffler (N. Y. C.), Crosby Miller (C. & O.), W. H. Moore (N. Y. N. H. & H.), P. B. Motley (C. P. R.), C. D. Purdon (St. L. S. W.), Albert Reichmann (Am. Br. Co.), J. W. Reid (C. & A.), A. F. Robinson (A. T. & S. F.), H. B. Seaman (Cons. Engr.), C. E. Smith (Cons. Engr.), I. F. Stern (Cons. Engr.), H. B. Stuart (G. T.), G. E. Tebbetts (K. C. T.), L. F. Van Hagan (Univ. of Wis.), Dr. J. A. L. Waddell (Cons. Engr.), H. T. Welty (N. Y. C.).

## Discussion

O. E. Selby (Chairman): Reference is made to subject 1, "Revision of Manual." (Mr. Selby then read this matter down to "submitted" in the second paragraph.)

I want to impress that on the members, that these specifications are 12 years old, far from complete and more or less out of date in many respects. We cannot hope to get a complete and satisfactory revision unless we get the ideas of members who have given the subject study. The only way to get that in satisfactory form, is to have them send the matter in to the committee in time to be incorporated in the draft. It would be out of the question to submit specifications to this convention, and have them acted on in detail. The committee presents one conclusion, which is as follows:

"It is concluded from information obtainable to date that the Schoop metal spraying process does not afford satisfactory protection from corrosion."

(After discussion this conclusion was accepted as information only).

(Mr. Selby then read the matter relating to Subject No. 3).

The President: I must confess that I have not read these specifications carefully, but they show evidence of hard work and considerable thought and study. It is hoped the members of the association will offer their criticisms as invited by the committee, as in this way only can we get the best work done.

(Mr. Selby read the matter under No. 4.)

Mr. Selby: These tests, as you know, are a continuation of tests that have been made by Prof. Turneaure's subcommittee for several years past, and the results of these particular tests are given in the form of a conclusion, although the matter is not presented to the convention in the form of a conclusion for adoption in the Manual.

C. P. Howard (I. C. C.): I ask whether that reference to electric locomotives includes the kind that have counterbalance and rods like a steam engine, like the Pennsylvania type, does that refer to that type?

Mr. Selby: The committee will revise that conclusion by the addition of a paragraph showing that there were no reciprocating parts in the locomotives used.

The President: The members will be interested in knowing that the Railway Bureau of the Government of India has requested by cable this week that two of the extensometers used by this committee and designed by Prof. Turneaure, be shipped to Simla, India, for the making of impact tests on the locomotives in that country.

(Mr. Selby read the matter under No. 5.)

Mr. Selby: These tests, as you know, have been continued as a series during several years past at the Bureau of Standards in Washington, and they have produced exceedingly valuable results.

(Mr. Selby then read the matter under No. 1, No. 2 and No. 3, on page 793.)

The President: There being no discussion, the matter will be approved and printed in the Manual.

(Mr. Selby here read the matter on subject No. 6.)

The President: As these have been before the members for a year, if there is no further discussion, the chair will entertain a motion to adopt them as a whole.

The President: That completes this report, and while we have a long program, I would suggest that we have a little general discussion on the subject of carrying over bridges and maintenance of bridges that probably would otherwise be replaced, but owing to the present conditions in the world and the difficulty of getting steel, cannot be. Some of the members may have some valuable information if they will tell us what they are doing in this direction.

P. B. Motley (C. P. R.): It seems to me that the Committee on Wooden Trestles and Wooden Stringers should be consulted in regard to the unit stresses in considering carrying over, as far as specifications are concerned, and the subject of over-stress. The Canadian Pacific has a long mileage, and about 68 miles of bridges, if they were all added together. These structures date from about 1887 to the present time. Last year we put in some concrete bridges which are of an extremely interesting character. I refer to two reinforced concrete trestles over 100 ft. high and 600 ft. long, where we are using 37-foot open spans. These trestles were erected by the usual methods of concrete building construction; that is to say, the towers were put up with the usual form work, and the slabs or open spans were put in by a 100-ton wrecking crane. The slabs themselves are made in T-sections, the upper part being used as a deck slab, as well as a compression member. They weigh about 55 tons, and the system of erection is decidedly interesting.

I mention this to show one of the ways in which we can carry over. The cost of steel is just now such as to lead our engineers to consider reinforced concrete, and these two instances are examples of what can be done. So that if our respective managements will not buy 300-foot spans of arch construction or other orthodox steel details, we can go to concrete for such things as trestle work. This is, in other words, the season for short spans. I think that is all I have.

R. H. Ford (C. R. I. & P.): It seems to me there are two thoughts that have to be kept in mind. The first is that we are in, probably, for a very long war. The second is that the roads of this country are going to be placed at a tremendous strain to carry the traffic with decreased manpower, as they have got to do during that period.

A. F. Robinson (A. T. & S. F.): Mr. Chairman and gentlemen: We have got to meet unusual conditions. It is generally relatively easy to determine as to just how much unit stress we dare carry in our steel structures. We may not be able to hold to the unit stress under these conditions even to reasonable limits. I have been asked to rate our bridges on the Cooper's series, with the idea that the Government Committee might be able to make our ratings, say, to E-50, E-55, or something of that sort.

We have got to consider not always what every one of us may count absolutely safe. We have got to find out just how far it is reasonably safe to go, and there will be different locations, different traffic conditions which will modify the judgment. We cannot lay down the rule positively.

There is one phase of this matter, gentlemen, which is not exactly a part of the work of this Committee, you may not call it. It is the timber bridges and timber stringers; 7 in. by 8 in. by 16 in. stringers, it is almost an impossibility to obtain today, because of the shipping work. It is an extremely difficult matter to lay down

fixed rules as to the maximum fiber stress permitted on the stringers. I have recommended to our people something in the way of a sliding rule. We do not adopt any maximum fiber stress. We found that on certain sections of the line we had broken stringers, say with a 3-ply chord, and on other sections of the line with very similar loading we had almost no broken stringers.

The only rule we can go by, I think, is this matter of the percentage or number of broken stringers. We cannot always expect to get along without broken ones. We must, however, use the limit. We have to consider those features, and not attempt to establish a fixed fiber stress. It is going to vary with the different climatic conditions and with different traffic conditions.

E. A. Frink (S. A. L.): Mr. President, it seems to me that judging the capacity of an existing structure is perhaps the most important and at the same time the most difficult problem that the engineer has to face. You can make formulæ for it, you can establish criteria, but they do not answer the full purpose that you want. You can establish certain limits of stress beyond which you ought not to go. But there are so many other questions that come in, that the unit stresses in themselves bear a comparatively small part. I realize the importance at this time of being as liberal as we can safely in allowing overloading of bridges, but personally I think that the matter already contained in the Manual, which establishes the limits which are considered safe for stresses, will be hard to improve upon, except that it would be very well, indeed, to make any investigation possible on the question; but I seriously doubt if we will be able to exceed those limits.

W. H. Courtenay (L. & N.): In many structures it is advisable to strengthen them and carry them over for several years, until the times become better for rebuilding, and a very simple expedient is to put falsework under them. We have had several viaducts we have treated in that way, and some girder bridges. Oftentimes it is feasible to strengthen any ordinary truss bridge by going over it carefully, and if we find the floor weak, or other parts, or the members subject to counter-stresses, strengthen them. That has been done to a considerable extent. Also improve the columns, particularly the top chord sections in some of the older bridges, triangular trusses, inserting additional columns, shorten the length of the top chord sections, and also suspending the web compression members so as to get rid of the effect of their weight. (Mr. Courtenay then described some unique strengthening work done on a trestle in Rigolets pass, on the Gulf coast.)

I. L. Simmons (C. R. I. & P.): It would seem to me with the material conditions as they are now today, that there has never been a time when railroads could so well afford to spend money on engineering as at the present time. You undoubtedly all have a number of bridges built prior to 1892. We have a great many, some of these are truss bridges and some of them are girder bridges. In the case of the truss bridges that were designed prior to 1892, you will find undoubtedly, even for the main sections in most cases they are very good, while the details are not strong enough. It is, therefore, for the engineer to determine what part of the structure is weak. You can well afford to spend considerable money to find out what is the matter and what are the determining features as to the rating of the bridge.

You may find the rivet connections are weak, and that it is a simple matter to ream out the ¾-in. rivet holes, and put in ⅞-in. rivets, which will usually take care of the trouble. After you determine what part of the structure is weak, and whether or not it can be repaired and strengthened, the next question is if the structure has to be changed, what can you put in, and that is the point where you can put in good time and money at this time. Many of the structures cannot be reduced in size. Some, of course, you will have to lengthen.

I believe we should then make a study to find out what kind of structure we can put in and where we can get material of bridge size. This will lead us into the use of concrete, of which I am very much in favor. I am not very much in favor of carrying bridges on falsework. I believe that isn't safe. You are justified in such a procedure only when the work has to be done and you do not have the money to do it properly. I believe it should be worked out gradually.

I believe it would be a good thing for this association to establish a permissible loading for branch lines, or recommended loading for branch lines. We cannot all make our branch lines the same strength we do our main lines. If we could work to that, I believe we would get somewhere with it.

B. R. Leffler (N. Y. C.): I wish to call attention to some methods of reinforcing old steel trestles. In one particular case a trestle was about 75 ft. in height, and an attempt was made to reinforce it by putting timber bents in the middle of the span. I regard that as a questionable practice. In fact, it may be absolutely dangerous. If timber had a co-efficience of elasticity as high as steel it might work, but being only about one-twentieth the co-efficient of steel, it can be easily seen that any load on a high trestle supported or re-enforced by wooden bents, the wooden bents would not take the load as might be supposed.

The same applies to re-enforced trusses. We have seen trusses with framed bents underneath panel points. The idea being to decrease the span. The result is some eye-bars are placed in compression, and there are a few of these points which must be borne in mind in using timber in conjunction with steel. Think of it in this way—a plate girder is supported rigidly at each end, and in the middle you attempt to support it by a spring about one-twentieth the elasticity of steel.

P. B. Motley (C. P.): If I may be permitted to say something more, I would like to make one remark about the question of overloading. One of the speakers spoke of arriving at a decision as to how we shall allow in our steel bridges for engines that are heavier than the ideal engine for which the bridge is designed.

After a long experience, I consider that it was impossible for this association or this committee to state a definite figure for this purpose. In our experience the only way we have found satisfactory is to classify the floor of a given bridge according to Cooper's loading, and the trusses likewise. Then the engine is also reduced to Cooper's loading, and then one sees quickly whether the flooring or the trusses are overstressed and how much.

Each bridge has to be considered from the point of view of its design, and sometimes a certain point is discovered to be the ruling factor, and then the engineer must use his common sense and fix the limit for the fiber stresses at that particular point. It is no easy task, and especially when the Vice-President and certain other officials want to run certain heavy engines over the road, and put up to you the problem of the investment at stake.

W. S. Bouton (B. & O.): The unit stresses given in the Manual are 22,000 lb. for iron and 26,000 lb. for steel, as the maximum limits for bridge spans used on our road for many years, and we have used those limits without any trouble. The bridges are figured on the

basis of the Cooper E loading and the engines are rated in accordance with the Cooper loading, and the structures worked out in detail. It was, of course, necessary to watch the action of the structures very carefully after they are put in service for some time, but normally there is no trouble at all under such loading. I do not think we can go much beyond the 26,000 lb. on steel. I think that in order to carry structures over during this period, that possibly the trestling of structures offers the quickest remedy.

(F. Auryansen (L. I.) described in some detail a method used for strengthening iron bridges that had steel beam floors carrying brick jack arches. J. L. Campbell (E. P. & S. W.) outlined an example of conservation in the case of the viaduct of the Southern Pacific over the Pecos river. This structure is one of the high bridges of the world. It became necessary to have a heavier structure, and a scheme was worked out for reinforcing the bridge, which was accomplished by putting in a third truss in the center line of the track and strengthening the columns by riveting additional angles to them.)

Mr. Leffler: I happen to think of another important feature in connection with taking care of old bridges. I have in mind bridges constructed with plate girders. In all my experience I have not found a plate girder that failed by direct tension in the bottom flange. It is nearly always a failure, if there is one, by buckling of the top flange, due to improper lateral bracing.

In many old concrete spans such as were made along in the 90's, the lateral system did not receive the attention in designing that it should have received, and by reviving the lateral system, which requires a very small amount of steel, many plate girder spans can be made very serviceable.

Another feature is to make old girder spans and double them up, and it seems to me that right there lies a field where the different roads could interchange material.

Mr. Auryansen: One simple expedient is to revert to the slow order. That immediately reduces our load. The only trouble is that it is very apt to be overlooked. These orders have to be observed, and it is not sufficient to have some papers in the file. Otherwise that method would automatically reduce our loads and increase the capacity of the bridges by just that much.

(The committee was excused with thanks.)

# Report of Committee on Signs, Fences and Crossings

LAST YEAR THE committee submitted considerable information relative to the depth and width of flangeways in use on steam and electric railways throughout the United States. Owing to the great variety in dimensions of flangeways and to the great amount of information submitted by the railroads, the committee was not able to present this information in the form it desired, nor was it able to make any study looking to a recommendation for standard dimensions of flangeways. During the year this information has been tabulated showing the dimensions of flangeways in use on the different steam and electric railways. After a careful consideration of this data, the committee recommends the following dimensions for flangeways:

STRAIGHT TRACK.

| Steam Railways: Depth of Flange | Steam Railways: Width of Flangeway | Steam Railways: Depth of Flangeway | Electric Railways: Depth of Flange | Electric Railways: Width of Flangeway | Electric Railways: Depth of Flangeway |
|---|---|---|---|---|---|
| M. C. B. Standard | 1¾ in. | 1⅞ in. | ⅞ in. | 1⅝ in. | 1⅛ in. |
| | | | 1 in. | 1⅝ in. | 1¼ in. |
| | | | 1⅛ in. | 1¾ in. | 1⅜ in. |

For flangeways in curved tracks of steam railways an increase in width of 1/16 in. for every 2 deg. of curvature over 2 deg. is recommended. For flangeways in curved tracks of electric railways no special increase is recommended, as the above dimensions cover ordinary operating conditions. On some roads the width of flangeway is increased as the gage is increased, so as to keep the distance between the gage line and the wearing surface of the opposite guard rail uniformly 4 ft. 6¾ in., which is good practice and recommended for excessive curvature.

For flangeways of steam railway tracks located in paved streets, the reports show widths generally ranging from 1½ in. to 2½ in., with one case each of 3 in. and 4 in. These flangeways are formed by rails laid on side, rails placed upright with separators, planks and other paving materials, and special guard rails. For flangeways of electric railway tracks, located in paved streets, the widths generally range between 1½ in. and 2 in., although one case reported a width of 3 in., another 3½ in.

The depth of flangeways of steam railway tracks varies generally from 1¼ in. to 2 in., with two cases of 3 in.; while the depth of flangeways of electric railway tracks varies generally from ⅞ in. to 1¾ in.

### Signs—The Principles of Design and Rules for Their Use

The committee had prepared a progress report embodying a set of signs for general use, the scheme being a rather radical departure from the signs at present in use on the railroads of the United States and Canada, in that lettering was largely eliminated. The underlying principle in the design was that signs used in connection with the operation of trains and for warning the public at highway crossings should be made as prominent as possible, while those delineating property and marking corporation limits, mileage, bridges, etc., should be made less conspicuous.

Upon taking the matter up with the committee on Signals and Interlocking, it was found that that committee had given the matter very careful consideration, and had arrived at the following conclusion:

"Some of the so-called signs govern train operation just as much as the movable semaphore of an interlocking or block signal system, and these signs are recognized in the standard code of the American Railway Association as signals. A note to the definition of fixed signal, on page 235 of the Rule Book of the American Railway Association, reads as follows: 'The definition of a *"Fixed Signal"* covers such signals as slow boards, stop boards, yard limits, switch, train order, block, interlocking, semaphore, disc, ball or other means for displaying indications that govern the movement of a train.' Under this definition, slow boards, stop boards, etc., are in fact signals. It seems that the work of this committee should be confined to designing these signals, and that the designing of information signals is properly a subject to be handled by committee No. 9, excepting that there

should be conference between the two committees to the end of avoiding any confliction which might result in confusion."

The committee is in accord with the above conclusion and can see no advantage in submitting another set of designs at this time.

In view of the fact that we now have government control of railroads, which may lead to the transfer of men from one road to another, as is being done with equipment, it would seem most desirable that uniform signs should be adopted by all railroads. As efforts are being made from year to year to secure more permanent materials for various structures, it is considered most desirable that concrete be utilized for all information signs and, when possible, for other signs, all suitably marked to convey the necessary information.

### Legal Requirements Relative to Right-of-Way Fences and Stock-Guards

Last year the committee submitted abstracts from the laws of the various states of the Union and Canada, on the legal requirements relative to the provision of fences for right-of-way and installation of stock-guards. In the discussion of the report at that time, it was suggested that a tabulated statement be prepared, giving the principal information shown in the abstracts—when the laws were passed, what constituted a legal fence, and other information of this character. The committee therefore presented, in tabulated form, the information suggested in the discussion.

The laws of but 19 states and the Dominion of Canada specify the height of a legal fence, and the laws of but 26 states and the Dominion of Canada specify the material to be used in their construction. The laws of a number of the remaining states are entirely silent on the matter of what constitutes a legal fence, some of the laws making no mention whatever of the material to be used or the height, but specifying in a general way that the right-of-way shall be fenced so as to turn the various kinds of live stock. In a few instances, the railroad companies are obliged to secure the approval of the railroad commission for both fences and stock-guards.

From the above, it would seem apparent that some concerted action should be taken by this Association, or by some other similar body, looking to the adoption of a uniform fence law. Under present conditions, it is difficult in many cases to decide damage cases on account of the uncertainty as to what constitutes a legal fence.

### Types of Fences

This year the committee collected a number of photographs illustrating special fences suitable for use around industrial plants, railroad yards, etc. The investigation has disclosed the fact that there is a great variety of fences in use at this time for the above purpose, ranging from the ordinary wood picket fence, in general use years ago, to the solid board fence surmounted by strands of barbed wire, and from the ordinary iron picket fence to the heavy galvanized woven wire fence, surmounted by strands of barbed wire, shown in the accompanying illustrations. These fences are usually about eight feet in height, and their use has increased very rapidly within the last year or two, particularly around industrial plants engaged in the manufacture of material used in connection with the prosecution of the war.

Another rather common form of fence around railroad property consists of angle iron rails and pickets with flat iron bars for posts and braces.

### Over and Under Grade Crossings

The committee presented abstracts of laws or regulations of the public utilities commissions of 47 states and the District of Columbia relative to over and under grade crossings—their method of construction, distribution of cost, etc.

### End or Strain Posts

It does not appear that special devices, which have been introduced by the manufacturers of steel posts to avoid the expense attendant upon the use of concrete with strain and corner posts, have been adopted by railroads to any extent. But one correspondent reports the use of such devices with tubular posts and, as these were only installed in 1917, their effectiveness has not been determined. The cost of the 8 ft. 6 in. No. 9 gage post in this instance is given at $2.80 and the cost of setting at 40 cents. Two of these devices are shown on the accompanying drawing. With that marked "A," a hole is dug for the strain post large enough to admit the anchor plate. After backfilling the hole the face plate is driven. The brace plate is driven after attachment to the brace rod. It is necessary to dig a trench to receive the lower end of the brace rod. The post shown at "B" is driven into the ground as indicated, the post is split at the bottom and is spread out as it nears its final position. This is accomplished by first driving to proper depth a rod having a wedge-shaped enlargement at the lower end greater in diameter than the interior of the post. This arrangement does not work very well in soft ground because the spreader will be forced down with the post.

Some information has been received from the manufacturers concerning a steel line post of U section. These posts are about 2 in. square. Rectangular steel pegs about 18 in. long are driven through slots in clips bolted on to the posts just below the ground surface to hold the fence in line. Strain and corner posts are tubular, 2½ in. or 3 in. in diameter. A horizontal tubular strut is placed between the strain post and the adjacent line post at about two-thirds the height of the fence and a tie wire or rod leads from the line post end of this strut to the strain post at the ground line. The manufacturers report considerable use of this fence about industrial plants and two railroad companies are also reported to be users. This post is also shown in the drawing.

Another form of anchor post is shown at "D." This post consists of two standard line posts placed back to back, and either bolted or riveted together, and braced by a standard line post attached to the anchor post as shown by the illustration. This style of post has been used considerably for fences subjected to the lighter service, and has also been used to some extent in railroad right-of-way fences.

Some companies have continued the use of wood strain and corner posts with steel line posts. This has the advantage of cheaper first cost, but its final economy depends, of course, on the relative length of life of the wood post, the steel line post and the wire.

The ordinary method of setting steel strain and corner posts in concrete is well illustrated in the standard fence of the Elgin, Joliet & Eastern. There is considerable variation in the amount of concrete used by different companies. Blocks 8 in. square by 36 in. deep are reported by one company, while another uses a block 20 in. square and 42 in. deep. A fair average for such blocks is 18 by 18 by 30 in. Brace rod blocks have about one-half the above volume.

Angular strain posts are provided with a cross angle, similar to a cleat, attached at the bottom by means of a triangular plate. Brace angles, which are attached to the

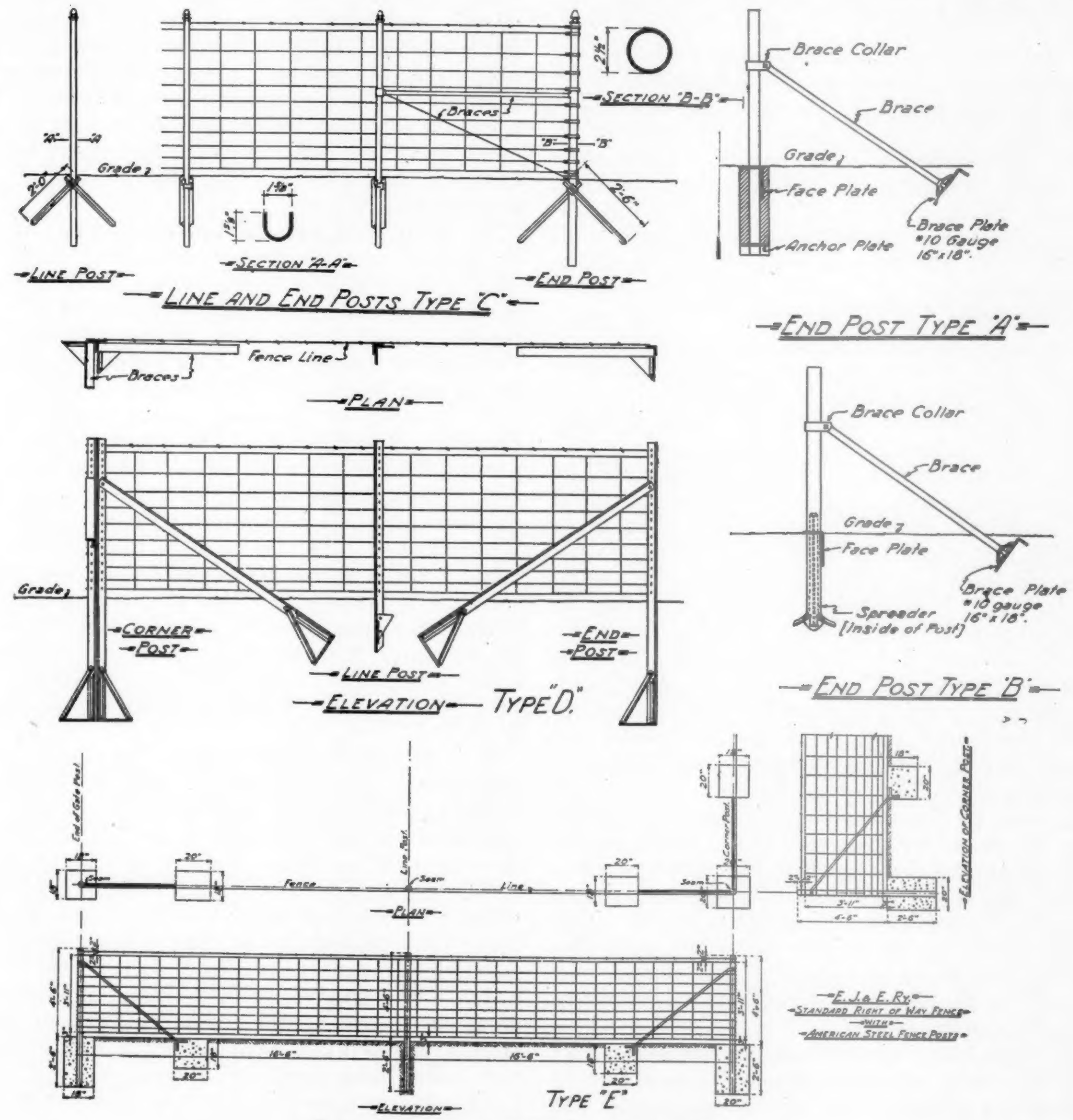
post by means of a bolt or rivet, are similarly enlarged at the bottom. Sufficient information to form an opinion as to the effectiveness of this arrangement has not been received.

### Concrete Fence Posts

While the committee does not have any definite data as to the annual expenditure of the railroads for fence posts, it is probable that it is considerably over $1,000,000. There are more than 250,000 miles of railroad lines in the United States and, while this committee does not know just what percentage of this mileage is fenced, it extensively have abandoned using concrete posts until a more satisfactory design has been gotten out or brought to their attention.

Of the 18 roads that have tried concrete posts, 10 favor their use, 1 favors steel, 3 favor wood and 4 are undecided. Of the 66 roads that are not using concrete posts, 3 favor the use of concrete posts, 1 favors steel and 8 favor wood. The other 54 roads did not express a preference. Thus, of the 25 roads that did express a preference about 50 per cent favor concrete posts, 10 per cent favor steel, and 40 per cent favor wood.

The committee is led to the conclusion that concrete



Several Designs of Fence Construction

is quite certain that there are at least 75 to 100 million posts in use, costing on the average 15 cents or more each.

Apparently the Pennsylvania Railroad began experimenting with concrete fence posts about five years before any of the other roads, the first posts being set by them in 1904. Such good results were obtained with these first posts that in 1909 they began to experiment on a larger scale. Since 1909 the use of concrete posts by railroads has gradually increased until at the present time there are about 800,000 in service. In a general way, it may be said that these posts are giving good satisfaction, although for various reasons a great many failures have occurred and several roads that have experimented quite line posts having a strength sufficient to resist a force of 200 lb. acting along or at right angles to the fence line and applied 60 in. above the ground line, the post acting as a cantilever beam, are strong enough to give good results. Too much stress can hardly be laid on the use of an adequate amount of steel properly placed. In 1914, under the direction of this committee, 78 concrete line posts of different types were tested to destruction at the Lewis Institute, Chicago. In spite of the fact that the concrete used in the posts varied in its crushing strength from 1,530 to 3,250 lb. per sq. in., every post failed in tension. It is probable that some of the failures were indirectly due to poor concrete, allowing the steel to slip,

but by far the greater number were due to the failure of the steel itself. Among the other things that were brought out by these tests was that stranded or crimped reinforcing should not be used, but that the steel, whether smooth or deformed, should be in the form of a straight, stiff bar. The committee also believes that square or round rods, moderately deformed, are preferable to strap iron, since the former permit the concentration of the steel further from the neutral axis and since the latter tend to set up lines of cleavage in the concrete.

The committee, in sending out its inquiry blanks this year, asked the members to describe the methods used to fasten the fencing to the line posts and to state what success they were having with such methods. Ten companies are using tie wires around the posts and 8 of the 10 express themselves as satisfied with this method. Five are using posts with a hole in the same through which a wire or a nail is passed and fastened to the reinforcing. Four of the 5 are satisfied with this method. Three companies are using staples embedded in the concrete, through which the tie wires or nails are passed for fastening the fencing; this method being satisfactory to all three. When posts are tapered, a tie wire around the post, if properly applied, will prevent stock from crowding the fencing down, but the experience of some roads indicates that it will not prevent hogs from raising it up, so that in districts where hogs are raised extensively some other method of fastening is preferable.

As to the annual cost of concrete line posts, it seems probable that with prices as high as they now are and will doubtless be for several years, the minimum will be about two and a half cents. In the case of materials that have a comparatively short life, such as wooden fence posts, anything that materially increases or decreases the average life will have a considerable effect on the annual cost. For example, if a wooden fence post costing 35 cents in place has a life of 10 years, its annual cost will be 4.55 cents; whereas, if its life were 15 years the annual cost would be only 3.22 cents. On the other hand, if concrete line posts costing 45 cents have an average life of 50 years, the annual cost would be 2.47 cents, and increasing the average life to 60 years would only reduce the annual cost to 2.38 cents. In other words, if we can produce concrete line posts that will have an average life of, say, 50 years, we gain very little, as far as annual cost is concerned, by adding a few more years to their life, and any material decrease in this annual cost will have to be effected by reducing the first cost. This brings out the fact that excessively large and expensive concrete posts are to be discouraged and that a post should be built to the size and strength that is economically profitable and no larger.

In line with this idea, it appears to this committee that any specification as to minimum size and reinforcing of concrete posts is a mistake. In spite of all devices and safeguards the quality of concrete is and will always be largely dependent on the human element and on local conditions, and the committee believes that such posts should be built to a minimum strength rather than size. Just what this strength should be, the committee is not prepared to say at this time, but it is quite certain that posts capable of withstanding a load of 200 lb. when tested as a cantilever beam would be strong enough and it is thought that this strength may be greater than is necessary, particularly in some localities.

### *Conclusions*

The conclusions of the committee, based on the information obtained this year, may be summed up as follows:

1. The committee repeats its conclusion of 1914 that, "Concrete fence posts are practical, economical and a suitable substitute for wood."
2. Reinforcement should be placed as near to the surface of the post as practicable, say ½ in. from the surface.
3. Posts should taper from base to top.
4. Square corners of posts should be rounded off to a radius of not less than 1 in.
5. Concrete should be made from clean, hard, aggregates, the percentage of the various sized grains being such as to produce a dense concrete, using screen analysis as a guide. The minimum size of the particles of gravel or crushed stone should not be less than ¼ in. nor more than ½ in. Concrete should be mixed in the proportion of one part cement to not more than four parts of mixed aggregate. Concrete should be of such a consistency that water can be brought to the surface by tamping; the use of an excess of water is detrimental. Concrete should be very thoroughly mixed in a batch, not a continuous mixer.
6. Reinforcing should be in the form of stiff round or square rods, preferably deformed, made from steel with a high elastic limit. Crimped or stranded reinforcing that would be straightened out when brought into tension should not be used. Some method of positively holding the reinforcing in its proper place in the post throughout its entire length should be used.
7. Jogging or vibrating molds to compact the concrete in the post, or some other method that will accomplish the same purpose, should be employed.
8. Posts should be carefully made so as to secure a uniform strength in substantially all posts, and this strength should usually be such that the post will withstand a force of not less than 180 lb. at right angles to the axis of the post, the post acting as a cantilever beam supported at the ground line and the force being applied 60 in. above the ground line. It is not economical to make posts that will have the strength to resist a force of over 200 lb. when the post is tested in the manner above described.
9. Square, or nearly square, posts are more efficient than round posts in resisting the forces that ordinarily cause failure, but the difference is not very great and may in some cases be offset by an increased resistance to deterioration and better methods of manufacture.
10. On account of the rapid failure of reinforced concrete when exposed to air containing salt spray, concrete fence posts should not be used within twenty or twenty-five miles from large bodies of salt water.
11. Posts should not be made out of doors in freezing weather. They should not be exposed to the sun, and should be sprinkled with water the first eight or ten days after being made to aid curing.
12. Molds should be carefully oiled or soaped to prevent concrete sticking to them.
13. Posts should be cured for not less than 90 days, when cured naturally, before being set or shipped.
14. Posts should be carefully handled and packed in straw, sawdust or other suitable material for shipment.
15. The study of the results obtained from concrete line posts should be continued from year to year and the results tabulated for the information of the Association.

### Analysis of Cost

For the purpose of making a revised analysis of the comparative annual cost of fences, inquiries were sent out soliciting data on concrete and steel line posts only, the intention being to use the data collected in 1915 for wood posts. In 1913, information was submitted with

respect to the comparative cost and economy of steel and wood posts. The figures relative to steel posts given at that time were furnished largely by the manufacturers. This year information has been received from 20 users of about 140,000 steel posts and 18 users of about 800,000 concrete posts and a comparison has been made between this and the rather full information relating to wood line posts, presented in 1915.

From 1915 data it appears that the average cost and life of wood posts is as follows:

| Kind of Wood | Life | First Cost | Handling | Setting | Total Cost |
|---|---|---|---|---|---|
| Bois D'arc | 26 Yrs. | 14c | 1.72 | 8.52 | 24¼c |
| Catalpa | 12 Yrs. | 17c | 1.72 | 8.52 | 27¼c |
| Cedar | 15 Yrs. | 16c | 1.72 | 8.52 | 26¼c |
| Chestnut | 11 Yrs. | 14c | 1.72 | 8.52 | 24¼c |
| Cypress | 11 Yrs. | 20c | 1.72 | 8.52 | 30¼c |
| Locust | 17 Yrs. | 20.5c | 1.72 | 8.52 | 30¾c |
| Oak | 9 Yrs. | 14.5c | 1.72 | 8.52 | 24¾c |
| Pine | 8 Yrs. | 11c | 1.72 | 8.52 | 21¼c |

Of the above the cedar post is the cheapest, with the exception of the Bois D'arc, and is used in much larger quantities than any of the others. The steel and concrete posts will be compared with it. Information received this year indicates the average first cost of the steel line post to be 27 cents and the cost of handling and setting, 7 cents. The average estimate of life is from 15 to 20 years. The average first cost of concrete line posts is about 25 cents, and the cost of handling and setting about 20 cents. The estimated life of concrete posts is placed at 50 years.

As in the 1913 report, interest is assumed at 6 per cent. The result of this comparison is as follows:

| | Wood | Steel | Concrete |
|---|---|---|---|
| Estimated average life | 15 yrs. | 20 yrs. | 50 yrs. |
| Average first cost in place | 0.2625 | 0.340 | 0.4500 |
| Annual Cost | | | |
| Interest on first cost at 6 per cent | 0.0157 | 0.0204 | 0.0270 |
| Amount to be set aside annually to reproduce first cost at end of life | 0.0113 | 0.0092 | 0.0015 |
| Total annual cost | 0.0270 | 0.0296 | 0.0285 |
| Cost per mile (640 posts) | 17.28 | 18.97 | 18.24 |

The above comparison should be considered as roughly approximate only, when applied to a particular case, because the life of wood, steel and concrete posts is affected by locality and the weight of metal and quality of galvanizing must be taken into account. At the present time steel posts are from 50 per cent to 75 per cent higher in price than quoted above, and deliveries are very indefinite.

The information received relative to the cost of strain and corner posts in place is so meager and variable that a comparison similar to the above for line posts does not seem warranted.

### Conclusions

The committee recommended in its report:

1. That the recommendations under "Flangeways" be approved and published in the Manual.
2. That the recommendations of the committee in reference to "Types of Fences" be approved and published in the Manual.
3. That the recommendations of the committee in reference to "Concrete Fence Posts" be approved and published in the Manual.
4. That the remainder of the report be accepted as information.

Committee: W. F. Strouse (B. & O.), chairman; Arthur Crumpton (G. T.), vice-chairman; F. D. Batchellor (C. H. & D.), H. E. Billman (M. P.), C. G. Bryan (I. C.), G. F. Black (Me. C.), A. C. Copland (C. & O.), A. S. Butterworth (M. P.), B. J. Dalton (M. K. & T.), F. T. Darrow (C. B. & Q.), G. N. Edmondson (N. Y. C.), R. C. Gowdy (F. W. & D. C.), Paul Hamilton (C. C. C. & St. L.), Maro Johnson (I. C.), L. C. Lawton (A. T. & S. F.), S. L. McClanahan (C. R. I. & P.), L. A. Mitchell (Un. Tr. Co.), T. E. Rust (W. C. F. & N.), A. Swartz (T. & W.), W. D. Warren (N. Y. N. H. & H.), W. D. Williams (Cin. Nor), K. G. Williams (C. R. I. & P.).

### Discussion

W. F. Strouse (Chairman): The committee was assigned eight different subjects. In reference to subject number 1, the report on this subject appears in appendix A, and the recommendations of the committee are given at the end of that section for approval and publication in the Manual. In connection with that report you will find series of tables giving the dimensions of flangeways of electric railways, steam railways, etc., and the conclusions that are recommended for placing in the Manual. I move the adoption of the sections concerning flangeways.

(Motion carried.)

C. E. Lindsay (N. Y. C.): I apprehend that there might be a possibility in widening the flangeway $\frac{1}{16}$ in. for every 2 deg. of curvature that it might in some cases violate the action of the guard-rail; that is, it might decrease the distance between the top of the rail and the frog point so that it would strike.

Mr. Strouse: I would say in answer to that, this contains the statement:

(Mr. Strouse read the sentence beginning "on some roads.")

I think that will take care of it, and that impression is borne out by the information that was furnished the committee, a great deal of which was not published in this report.

Mr. Lindsay: That is obligatory, that it shall not violate that distance.

Mr. Baldridge: I should like to ask the committee whether or not it has taken into consideration in fixing this width of flangeway, the proposal which has been acted upon, I think, by some other committee, sanctioning the thickening of the flanges of the wheels?

Mr. Strouse: So far as I know that matter has not been given consideration.

Mr. Baldridge: If I remember correctly, one of the other committees has in its report a statement sanctioning the proposal of the Master Car Builders' Association thickening the car wheel flange ⅛ in. If that matter has not been considered by this committee, it seems to me it would be advisable to hold this another year to consider that.

John R. Leighty (M. P.): There is no reason why we should defer action on this committee's work on account of the subject just mentioned, so long as this report does not violate any of the conditions proposed. The design of frogs and switches and their flangeways will be taken care of in the same way as the other.

Mr. Baldridge: If I remember our flanges for frogs and switches, they provide for 1⅞ in. on the rail side and 1¾ in. on the frog side. That gives ⅛ in. more in that case than we are providing in this case. Unless that matter has been considered, I think the committee should take it up. As I remember, the other report provided for sanctioning the thickening of the flange of the wheels, provided the face of the flange of the wheel extended a certain amount. Why not refer this back and have the adjustment made?

The President: My idea was that it was the face-to-face distance, wasn't it?

Mr. Baldridge: I understand the face is the side of the flange next the rail.

The President: The point that seems to be dangerous here, if you get up to 25 deg. you have gone beyond the limit of that equation. However, it is immaterial.

Mr. Strouse: Last year copies of the laws relating to

fences for rights of way were presented, and the committee was asked to tabulate the principal information contained in those laws. This has been done, and is presented as information.

The President: It will be so accepted.

Mr. Strouse: Subject No. 5 is, report on Classification of Fences into Types. Several years ago the committee revised the specification for fences as given in the Manual and submitted considerable other information as in connection therewith. This year we have some photographs of a number of different styles of fences that are used. The committee recommends the inclusion of these photographs in the Manual as supplementing the sketches that are already in the Manual for illustrating other styles of fence.

I remember several years ago that in discussing the specifications for fences, the association was very guarded in recommending any particular type of fence; but it seems to me that that point could be covered very nicely by the passage of uniform fence laws. As it is now some of the fences are 4 ft. high, some are 4½ ft., some are allowed to be constructed of wood in various combinations, and others posts of various types, the result being that a different construction might be placed on what constitutes a legal fence in every state.

Mr. Lindsay: I was going to ask, whether the committee considered that with these illustrations and the material already in the Manual, they have shown all types of fences that are used on railroads.

Mr. Strouse: No, I would not say all types.

Your chairman was somewhat in doubt as to just what was meant by being asked to report on classification of fences into types. It did not seem to me to be anything very definite in the wording of the subject.

F. Auryansen (L. I.): There are two types of fence, one you can see through and the other that you cannot. I think the committee ought to get some data regarding concrete fences.

Mr. Baldridge: As there seems to be divergence of opinion, I move that this be referred back to the committee for another year.

The President: The committees say they will accept that suggestion.

R. C. Gray (B. & O.): Under the title, Ohio, the statement is made "the power to deal with matters of this nature is vested in municipalities." I think that statement should be made in counties and municipalities. In Ohio we have about as many overtures from boards of county commissioners as we have from municipalities.

The President: The committee will accept that.

Mr. Strouse: Appendix G is a further study on the subject of concrete fence posts; in other words, the subject has been brought down to date. Tables were prepared from information received from various railroads which have given the use of square posts, round posts, etc. The conclusions arrived at by the committee under the subject of concrete posts are similar to the conclusions that are at present in the Manual, except that they are somewhat more elaborate. This is supposed to be a substitute for what is in the Manual.

Prof. Talbot: In Sec. 10 I find no reference to the data on which that conclusion was based. Can the committee give us any further information in their report?

Mr. Auryansen: I might say in answer to Prof. Talbot that 25 miles from salt water includes all of Long Island, and the Long Island Railway built quite a number of fences having 3-in. slabs which were reinforced and properly held in place so that they could remain in the center of the slab. The fences are over 10 yrs. old and there is absolutely no sign of deterioration.

Prof. Talbot: In view of that statement, I make the motion that that No. 10 be referred back to the committee.

A. O. Wilson (S. A. L.): Mr. President, the Navy Yard at Charleston is enclosed with reinforced concrete posts, and they show no deterioration whatever. This fence has been up a number of years, and I don't think that paragraph 10 will hold.

Mr. Strouse: In regard to that point, I only know in a general way that there have been a good many failures in concrete exposed to salt water, but whether it is necessary to place such a distance between the salt water and the structure is another question. I rather feel myself that that is a little too great a distance. I move that these conclusions, with the exception of No. 10, be adopted and placed in the Manual, as revised.

(The motion was carried.)

Mr. Strouse: There is one other subject, number 8. The committee undertook to revise the cost and bring it down to date, but found the present time rather a bad one to attempt anything elaborate in that direction, on account of the excessive cost of labor and material, and the cost analysis that is given deals with the cost of various kinds of posts that have been in vogue the last few years. It is only submitted as information.

The President: It will be so accepted.

(The committee was dismissed with the thanks of the association.)

# Report of Special Committee on Stresses in Track

The joint committee of the American Railway Engineering Association and the American Society of Civil Engineers has been conducting elaborate experiments on the action of track under standing and moving loads for the last five years. An extensive progress report was published in the Proceedings of the American Society of Civil Engineers for January, 1918. This same report was also presented to the American Railway Engineering Association yesterday. This report was abstracted in the *Railway Age* of February 22, page 403.

Committee: A. N. Talbot (Univ. of Ill.), W. M. Dawley (Erie), A. S. Baldwin (I. C.), G. H. Bremner (I. C. C.), W. J. Burton (M. P.), Chas. S. Churchill (N. & W.), W. C. Cushing (P. L. W.), Dr. H. P. Dudley (N. Y. C.), Robt. W. Hunt (Con. Engr.), J. B. Jenkins (B. & O.), George W. Kittredge (N. Y. C.), P. M. LaBach (C. R. I. & P.), G. J. Ray (D. L. & W.), H. R. Safford (G R.), Earl Stimson (B. & O.), F. E. Turneaure (Univ. of Wis.), J. E. Willoughby (A. C. L.).

## Discussion

Prof. Talbot (Chairman): The committee on Stresses in Track presents its first progress report. The report includes first an analysis of the action of track as an elastic structure; second, the description of the instruments and apparatus used, and the methods of conducting tests; and third, the results of the tests.

It is felt that the analysis of the action of the track as an elastic structure is of value, in giving something to permit comparison of results, and to add comprehension to what may be expected in track action. The Manual assumes a uniform elastic support, which, of course, is not the condition where ties are used, and is not the condition where the track is not well tamped, but it does

indicate some of the effects of the kind of ballast, of spacing and size of ties and the effect of the moment of inertia of the rail section. These enter into the treatment.

The results of the tests given here are mainly those relating to stresses in the rail, the work on stresses in ties, depression of the ties and the conclusion of distribution of the pressure downward and laterally through the ballast being held for a later report.

In regard to the stresses in rails, the report gives something on the effect of the load itself in forming a stress in the rail; of the distribution of the load along the rail as in the case of trucks or drivers of different spacing; gives something about the effect of the weight of rail with reference to the bending moment, as well as to the weight the moment develops, as well as to the stresses found in the rail.

Since this report was presented, tests have been made further, on the matter of the counter-weight. It seems best to refer to that here, in order that the impression may not prevail that since no differences were found in the tests made as reported here on the effect of the position of the counter-weight of the drivers of the locomotive, that may not be considered to be the finding of the committee. In a case where tests have just been worked up, rather excessive effects were found from a locomotive which was undoubtedly either badly balanced or poorly designed.

The President: I would say that this was a little better than a report, that this was a classic, and judging from a mere glance at it, it would look as though we might spend considerable time in the discussion of it if the lateness of the hour did not forbid. I understand the committee will continue this work and submit another report at the next convention.

(The committee was dismissed with the very sincere thanks of the association for the very good work that apparently has been done.)

# Report of Committee on Rail

THE MANUAL FOR 1915, page 88, shows three locations of borings for chemical analyses of rails, one in an upper corner of the head, one in the interior of the head near the web and the third in a flange. Experience and special tests have shown that the samples from the corner of the head and from the flange have about the same chemical composition and for general purposes the flange sample may be omitted.

The same page of the Manual also shows a drawing for the tensile test specimen of ½-in. diameter and 2-in. gage length, with threaded ends. This followed the standard of the American Society for Testing Materials, which have modified its standard by omitting the threaded ends and allowing the ends to be of any form which will fit the holders of the testing machine. Our drawing should also be modified in the same manner to accord with current practice in testing laboratories. The Rail Committee recommends this drawing be substituted for the one on page 88 of the 1915 Manual.

The 1915 Manual contains "Specifications for High-Carbon Steel Joint Bars" (page 89) and "Specifications for Heat-Treated, Oil-Quenched Steel Joint Bars" (page 91). At the convention of the Association in March, 1916, the committee submitted "Specifications for Quenched Carbon and Quenched Alloy Steel Joint Bars," to be held over for one year. At the 1917 convention, some changes were submitted and it was again recommended that the specifications be held over for another year. The committee now presents these specifications as modified last year, with the recommendation that they be adopted and supersede in the Manual the "Specifications for Heat-Treated, Oil-Quenched, Steel Joint Bars."

## Specifications for Quenched Carbon and Quenched Alloy Steel Joint Bars

**Access to Works**

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the joint bars have been made in accordance with the terms of the specifications.

**Place for Tests**

2. All tests and inspection shall be made at the place of manufacture, prior to loading, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

**Rejection at Destination**

3. Joint bars which show injurious defects subsequent to their acceptance at the place of manufacture or sale will be rejected and returned to the manufacturer, who shall pay the freight charges both ways.

**Material**

4. Material for joint bars shall be steel made by the Open-Hearth process or an acceptable alloy steel.

**Chemical Properties**

5. The chemical composition of each melt of steel from which joint bars are manufactured shall be within the following limits:

| | |
|---|---|
| Carbon, per cent | 0.42 to 0.55 |
| Phosphorus, per cent, maximum | 0.04 |

Note.—In the event of nickel and chromium being present to the extent of 1.00 per cent and 0.35 per cent, respectively, these elements will be considered as the equivalent of 0.07 per cent of carbon in the above requirements.

6. The manufacturer shall furnish the inspector a complete report of ladle analysis showing carbon, manganese, phosphorus and sulphur content of each melt represented in the finished material. The purchaser may make a check analysis from the finished material; such analysis shall conform to the requirements of Section 5.

**Physical Properties and Tests**

7. Joint bars shall conform to the following physical requirements:

| | Quenched Steel | Alloy Steel |
|---|---|---|
| (a) Tensile strength, lb. per sq. in., minimum | 100,000 | 110,000 |
| (b) Elastic limit, lb. per sq. in., minimum | 70,000 | 85,000 |

(c) Elongation, per cent in 2 in., not less than $\frac{1,600,000}{\text{Ten. Str.}}$

Minimum, 12 per cent.

(d) Reduction in area, per cent, not less than $\frac{3,500,000}{\text{Ten. Str.}}$

Minimum, 25 per cent.

(e) Cold bending of the quenched bar without sign of fracture on the outside of the bent portion through 90 deg. around an arc, the diameter of which is three times the thickness of the test specimen.

8. All test specimens shall be cut from finished bars.

(a) The tension test specimens shall be about 4¼ in. long with threaded or unthreaded ends, and with the central 2-in. length turned to a ½-in. diameter, in accordance with the form and dimensions for tension test specimens of the American Society for Testing Materials.

(b) The bend test specimens shall be ½-in. square in section or a rectangular bar ½-in. thick with two parallel faces as rolled.

(c) The elastic limit shall be determined by the use of the Berry strain gage, or similar instrument, and will be the load when the elongation shows a change in the rate of stretch, the machine being operated at not more than ¼-in. per minute. After the elastic limit is reached the speed shall not exceed 2 in. per minute.

**Quenching**

9. (a) Joint bars shall be quenched in oil, or water if so specified, from a temperature of about 810 deg. C. (1490 deg. F.) and shall be kept in the bath until cold enough to be handled. A group thus treated is known as a quenching charge.

(b) Material which requires quenching in water will be acceptable at the option of the purchaser, provided it meets the requirements of the specification in all other respects.

**General Requirements**

10. Joint bars shall be rolled to dimensions specified in drawing furnished by the purchaser. No variation will be allowed in the dimensions affecting the fit and the fishing spaces of the rail. The maximum camber in either plane shall not exceed 1/32-in. in 24 in.

11. Joint bars shall be sheared to the length prescribed by the purchaser and shall not vary therefrom by more than ⅛ in.

12. (a) All joint bars shall be punched, slotted and shaped at a temperature of not less than 800 deg. C. (1470 deg. F.).

(b) All bolt holes shall be punched in one operation without bulging or distorting the section, and the bars shall be slotted when required for spikes in accordance with the purchaser's drawing, the slotting being done in one operation. A variation of 1/32-in. in location of the holes will be allowed.

13. All types of joint bars shall be finished smooth and true without swelling over or under the bolt holes, and shall be free from flaws, seams, checks or fins. The fishing angles shall be fully maintained.

**Branding**

14. The rolled bar shall be branded or marked for identification in the following manner and a portion of this marking shall appear on each finished joint bar:

(a) A portion of the name of the manufacturer, the year of manufacture, the numbered design and the kind of material shall be rolled in raised letters and figures on the outside of the bars.

(b) The letters "O H" shall be used to indicate "Open-Hearth Steel."

(c) The letter "Q" shall be used to show that the joint bars have been "quenched." If the joint bars are also tempered, the letters "Q T" shall be used to show that they have been "quenched and tempered."

(d) The number of the melt shall be plainly stenciled on each lot of bars.

**Inspection**

15. The joint bars from each melt or heat treatment lot shall be piled separately until tested and inspected by the inspector. One joint bar for tension test shall be selected by the inspector for each melt or heat treatment lot represented in finished bars. One joint bar for bend test shall be selected by the inspector for each lot of 1,000 bars or less presented or from each heat treatment lot.

## Rail Failure Statistics

The statistics covering rail failures for the period ending October 31, 1916, were issued in Bulletin 199 for September, 1917. The average failures per 100 track miles of the rollings for the several years, including both Bessemer and open-hearth rails, are given herewith. This summary includes statistics from reports for 1913, 1914, 1915 and 1916:

| Year | Years Service | | | | |
|---|---|---|---|---|---|
| Rolled | 1 | 2 | 3 | 4 | 5 |
| 1908 | .... | .... | ..... | ..... | 398.1 |
| 1909 | .... | .... | ..... | 224.1 | 277.8 |
| 1910 | .... | .... | 124.0 | 152.7 | 198.5 |
| 1911 | .... | 77.0 | 104.4 | 133.3 | 176.3 |
| 1912 | 28.9 | 32.1 | 49.3 | 78.9 | ..... |
| 1913 | 12.5 | 25.8 | 44.8 | ..... | ..... |
| 1914 | 8.2 | 19.8 | ..... | ..... | ..... |
| 1915 | 8.9 | .... | ..... | ..... | ..... |

It will be noted that the four years' rollings from 1908 to 1911, inclusive, show successively decreased numbers of failures compared on a basis of five years' service and the later rollings compared on a shorter period of service also show reductions. The improvement may probably be ascribed mostly to three things, namely, the gradual replacement of Bessemer by open-hearth rails, the adoption of heavier rails with stronger bases, and the improvement of the metal used for rails.

## Special Investigations

During the year special reports have been presented by the Rail committee as follows:

No. 64—Mill Inspections of Rail in 1915 and 1916, by M. H. Wickhorst.

No. 65—Rail Failure Statistics for 1916, by M. H. Wickhorst.

No. 66—Influence of Gage Length on Elongation in Drop Test of Rails, by M. H. Wickhorst.

No. 67—Tests of Manganese Steel Rails, by M. H. Wickhorst.

No. 68—Inhibited or Delayed Transformations in Rail Heads, by Dr. P. H. Dudley.

No. 69—Intensity of Pressure on Rails, by a Sub-Committee, J. R. Onderdonk, chairman.

## Track Bolts and Nutlocks

At the convention in March, 1916, the Rail committee submitted "Specifications for Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts," and "Specifications for Medium Carbon Steel Track Bolts with Nuts," as shown on pages 490-494, inclusive, of the 1916 Proceedings. The action of the convention was that these specifications be "held under consideration during the coming year with a view to final action next year." No action was taken on this matter at the 1917 convention. The committee now recommends that the specifications submitted in 1916, with some changes, be adopted by the Association for insertion in the Manual in place of the "Specifications for Track Bolts" appearing on pages 123, 124 and 125 of the 1915 edition.

## Specifications for Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts

**Access to Works**

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed and shall have all reasonable facilities afforded them by the manufacturer

to satisfy them that the bolts and nuts have been made in accordance with the terms of the specifications.

**Place for Tests**

2. All tests and inspection shall be made at the place of manufacture, prior to loading, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

**Rejection at Destination**

3. Bolts and nuts which show injurious defects subsequent to their acceptance at the place of manufacture or sale will be rejected and returned to the manufacturer, who shall pay the freight charges both ways.

**Material**

4. Material for bolts shall be steel made by the Open-Hearth process or an acceptable alloy steel. It shall be homogeneous and when broken in tension, shall show a uniformly silky fracture. Material for the nuts shall be soft, untreated steel.

**Chemical Properties**

5. The chemical composition of each melt of steel from which track bolts are manufactured shall be within the following limit:

Phosphorus, per cent, maximum....................................0.04

6. The manufacturer shall furnish the inspector a complete report of ladle analysis showing carbon, manganese, phosphorus and sulphur content of each melt, represented in the finished material and any other elements used to obtain the specified physical properties. The purchaser may make a check analysis from the finished material; such analysis shall conform to the requirements of Section 5. The drillings for check analysis shall be taken parallel to the axis and from the end of the finished bolt.

**Physical Properties and Tests**

7. Track bolts shall conform to the following physical requirements:

| | Carbon Steel | Alloy Steel |
|---|---|---|
| (a) Tensile strength, lb. per sq. in., minimum....... | 100,000 | 110,000 |
| (b) Yield point, lb. per sq. in., minimum............ | 70,000 | 85,000 |
| (c) Elongation, per cent, in 2 in., not less than............ | $\frac{1,600,000}{\text{Ten. Str.}}$ | |
| Minimum, 12 per cent. | | |
| (d) Reduction in area, per cent, not less than............. | $\frac{3,500,000}{\text{Ten. Str.}}$ | |

(e) Cold bending of the unthreaded portion of the finished bolt without fracture on the outside of the bent portion through 90 deg. around an arc, the diameter of which is three times the thickness of the test specimen.

8. All test specimens shall be from the finished bolts.

(a) The tension test specimens shall be about 4¼ in. long with threaded or unthreaded ends, and with the central 2-in. length turned to a ½-in. diameter, in accordance with the form and dimensions for tension test specimens of the American Society for Testing Materials.

(b) The yield point shall be determined by the strain gage.

**Quenching**

9. (a) Track bolts shall be treated by quenching in oil or water, if so specified, from a temperature of about 810 deg. C. (1490 deg. F.) and shall be kept in the bath until cold enough to be handled; a group thus treated being known as a quenching charge.

(b) Material which requires quenching in water will be acceptable at the option of the purchaser, provided it meets the requirements of the specification in all other respects.

**General Requirements**

10. Track bolts and nuts shall be made to dimensions specified in drawing furnished by the purchaser with allowable variations in dimensions of bolts from standard as follows:

Length, ⅛ in.

Diameter of shank, 1/64 in.

Shoulder, 1/64 in.

Diameter of rolled thread not more than 1/16 in. over the diameter of the body of ⅞-in. bolts.

Diameter of rolled thread not more than 3/32 in. over the diameter of the body of 1-in. bolts.

Variation in dimensions of elliptical shoulders under head of bolt of 1/32 in.

11. The heads and nuts shall be free from checks or burrs of any kind. All finished pieces shall be smooth, straight, of uniform size, with well-shaped symmetrical bends and well-filled heads, free from injurious mechanical defects, and be finished in a first-class, workmanlike manner. The head shall be concentric with and firmly joined to the bottom of the bolt with the underside of the head at right angles to the body of the bolt. The threads on the bolts shall be rolled, unless otherwise specified, shall be full and clean and shall be made in section and pitch according to the purchaser's standard. The fit between threads on the bolt and nut shall be accurate and nut shall go on with a 10-in. wrench from second to fifth turn. The force to turn the nut completely on the bolt with a 24-in. wrench shall not be more than 60 nor less than 40 lb.

12. (a) The nuts shall be made of soft untreated steel and shall be ¼-in. thicker than the standard nuts used for untreated bolts. They shall be of sufficient strength to develop the ultimate breaking strength of the bolts.

(b) Nuts of standard thickness will be accepted at the option of the purchaser if proved to be of sufficient strength to equal the ultimate breaking strength of the bolts. The length of the bolts shall be correspondingly reduced.

**Branding**

13. The heads of the bolts shall bear the manufacturer's identification symbol. The letter "Q" shall be used to show that the bolts have been "quenched." If the bolts are also tempered, the letters "QT" shall be used to show that they have been "quenched and tempered."

**Marking and Shipping**

14. When the bolts are shipped they shall have the nuts applied for at least two threads, be well oiled to prevent rust, and shall be packed in securely hooped kegs of 200 lb. net. All kegs shall be plainly marked as to material, size of bolts and name of manufacturer.

**Inspection**

15. Tension and bend tests shall be made of the test specimens selected by the inspector from each lot of 50 kegs. One specimen shall be selected for each test, and if it meets the requirements of the specification, the lot will be accepted. If the test specimen fails, two additional specimens shall be tested in the same manner as the one which failed, and if they meet the requirements of the specification, the lot will be accepted. If, however, either one of the pieces fails, the lot will be rejected. Both tension and bend tests shall pass the requirements for acceptance.

### Specifications for Medium Carbon Steel Track Bolts with Nuts

**Access to Works**

1. Same as above.

**Place for Tests**

2. Same as above.

8. All test specimens shall be cut from finished bars.

(a) The tension test specimens shall be about 4¼ in. long with threaded or unthreaded ends, and with the central 2-in. length turned to a ½-in. diameter, in accordance with the form and dimensions for tension test specimens of the American Society for Testing Materials.

(b) The bend test specimens shall be ½-in. square in section or a rectangular bar ½-in. thick with two parallel faces as rolled.

(c) The elastic limit shall be determined by the use of the Berry strain gage, or similar instrument, and will be the load when the elongation shows a change in the rate of stretch, the machine being operated at not more than ¼-in. per minute. After the elastic limit is reached the speed shall not exceed 2 in. per minute.

**Quenching**

9. (a) Joint bars shall be quenched in oil, or water if so specified, from a temperature of about 810 deg. C. (1490 deg. F.) and shall be kept in the bath until cold enough to be handled. A group thus treated is known as a quenching charge.

(b) Material which requires quenching in water will be acceptable at the option of the purchaser, provided it meets the requirements of the specification in all other respects.

**General Requirements**

10. Joint bars shall be rolled to dimensions specified in drawing furnished by the purchaser. No variation will be allowed in the dimensions affecting the fit and the fishing spaces of the rail. The maximum camber in either plane shall not exceed 1/32-in. in 24 in.

11. Joint bars shall be sheared to the length prescribed by the purchaser and shall not vary therefrom by more than ⅛ in.

12. (a) All joint bars shall be punched, slotted and shaped at a temperature of not less than 800 deg. C. (1470 deg. F.).

(b) All bolt holes shall be punched in one operation without bulging or distorting the section, and the bars shall be slotted when required for spikes in accordance with the purchaser's drawing, the slotting being done in one operation. A variation of 1/32-in. in location of the holes will be allowed.

13. All types of joint bars shall be finished smooth and true without swelling over or under the bolt holes, and shall be free from flaws, seams, checks or fins. The fishing angles shall be fully maintained.

**Branding**

14. The rolled bar shall be branded or marked for identification in the following manner and a portion of this marking shall appear on each finished joint bar:

(a) A portion of the name of the manufacturer, the year of manufacture, the numbered design and the kind of material shall be rolled in raised letters and figures on the outside of the bars.

(b) The letters "O H" shall be used to indicate "Open-Hearth Steel."

(c) The letter "Q" shall be used to show that the joint bars have been "quenched." If the joint bars are also tempered, the letters "Q T" shall be used to show that they have been "quenched and tempered."

(d) The number of the melt shall be plainly stenciled on each lot of bars.

**Inspection**

15. The joint bars from each melt or heat treatment lot shall be piled separately until tested and inspected by the inspector. One joint bar for tension test shall be selected by the inspector for each melt or heat treatment lot represented in finished bars. One joint bar for bend test shall be selected by the inspector for each lot of 1,000 bars or less presented or from each heat treatment lot.

## Rail Failure Statistics

The statistics covering rail failures for the period ending October 31, 1916, were issued in Bulletin 199 for September, 1917. The average failures per 100 track miles of the rollings for the several years, including both Bessemer and open-hearth rails, are given herewith. This summary includes statistics from reports for 1913, 1914, 1915 and 1916:

| Year Rolled | Years Service 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1908 | .... | .... | ..... | ..... | 398.1 |
| 1909 | .... | .... | ..... | 224.1 | 277.8 |
| 1910 | .... | .... | 124.0 | 152.7 | 198.5 |
| 1911 | .... | 77.0 | 104.4 | 133.3 | 176.3 |
| 1912 | 28.9 | 32.1 | 49.3 | 78.9 | ..... |
| 1913 | 12.5 | 25.8 | 44.8 | ..... | ..... |
| 1914 | 8.2 | 19.8 | ..... | ..... | ..... |
| 1915 | 8.9 | .... | ..... | ..... | ..... |

It will be noted that the four years' rollings from 1908 to 1911, inclusive, show successively decreased numbers of failures compared on a basis of five years' service and the later rollings compared on a shorter period of service also show reductions. The improvement may probably be ascribed mostly to three things, namely, the gradual replacement of Bessemer by open-hearth rails, the adoption of heavier rails with stronger bases, and the improvement of the metal used for rails.

## Special Investigations

During the year special reports have been presented by the Rail committee as follows:

No. 64—Mill Inspections of Rail in 1915 and 1916, by M. H. Wickhorst.

No. 65—Rail Failure Statistics for 1916, by M. H. Wickhorst.

No. 66—Influence of Gage Length on Elongation in Drop Test of Rails, by M. H. Wickhorst.

No. 67—Tests of Manganese Steel Rails, by M. H. Wickhorst.

No. 68—Inhibited or Delayed Transformations in Rail Heads, by Dr. P. H. Dudley.

No. 69—Intensity of Pressure on Rails, by a Sub-Committee, J. R. Onderdonk, chairman.

## Track Bolts and Nutlocks

At the convention in March, 1916, the Rail committee submitted "Specifications for Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts," and "Specifications for Medium Carbon Steel Track Bolts with Nuts," as shown on pages 490-494, inclusive, of the 1916 Proceedings. The action of the convention was that these specifications be "held under consideration during the coming year with a view to final action next year." No action was taken on this matter at the 1917 convention. The committee now recommends that the specifications submitted in 1916, with some changes, be adopted by the Association for insertion in the Manual in place of the "Specifications for Track Bolts" appearing on pages 123, 124 and 125 of the 1915 edition.

### Specifications for Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts

**Access to Works**

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed and shall have all reasonable facilities afforded them by the manufacturer

to satisfy them that the bolts and nuts have been made in accordance with the terms of the specifications.

**Place for Tests**

2. All tests and inspection shall be made at the place of manufacture, prior to loading, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

**Rejection at Destination**

3. Bolts and nuts which show injurious defects subsequent to their acceptance at the place of manufacture or sale will be rejected and returned to the manufacturer, who shall pay the freight charges both ways.

**Material**

4. Material for bolts shall be steel made by the Open-Hearth process or an acceptable alloy steel. It shall be homogeneous and when broken in tension, shall show a uniformly silky fracture. Material for the nuts shall be soft, untreated steel.

**Chemical Properties**

5. The chemical composition of each melt of steel from which track bolts are manufactured shall be within the following limit:

Phosphorus, per cent, maximum....................................0.04

6. The manufacturer shall furnish the inspector a complete report of ladle analysis showing carbon, manganese, phosphorus and sulphur content of each melt, represented in the finished material and any other elements used to obtain the specified physical properties. The purchaser may make a check analysis from the finished material; such analysis shall conform to the requirements of Section 5. The drillings for check analysis shall be taken parallel to the axis and from the end of the finished bolt.

**Physical Properties and Tests**

7. Track bolts shall conform to the following physical requirements:

| | Carbon Steel | Alloy Steel |
|---|---|---|
| (a) Tensile strength, lb. per sq. in., minimum....... | 100,000 | 110,000 |
| (b) Yield point, lb. per sq. in., minimum............ | 70,000 | 85,000 |
| (c) Elongation, per cent, in 2 in., not less than............ Minimum, 12 per cent. | $\frac{1,600,000}{\text{Ten. Str.}}$ | |
| (d) Reduction in area, per cent, not less than............ | $\frac{3,500,000}{\text{Ten. Str.}}$ | |
| (e) Cold bending of the unthreaded portion of the finished bolt without fracture on the outside of the bent portion through 90 deg. around an arc, the diameter of which is three times the thickness of the test specimen. | | |

8. All test specimens shall be from the finished bolts.

(a) The tension test specimens shall be about 4¼ in. long with threaded or unthreaded ends, and with the central 2-in. length turned to a ½-in. diameter, in accordance with the form and dimensions for tension test specimens of the American Society for Testing Materials.

(b) The yield point shall be determined by the strain gage.

**Quenching**

9. (a) Track bolts shall be treated by quenching in oil or water, if so specified, from a temperature of about 810 deg. C. (1490 deg. F.) and shall be kept in the bath until cold enough to be handled; a group thus treated being known as a quenching charge.

(b) Material which requires quenching in water will be acceptable at the option of the purchaser, provided it meets the requirements of the specification in all other respects.

**General Requirements**

10. Track bolts and nuts shall be made to dimensions specified in drawing furnished by the purchaser with allowable variations in dimensions of bolts from standard as follows:

Length, ⅛ in.
Diameter of shank, 1/64 in.
Shoulder, 1/64 in.

Diameter of rolled thread not more than 1/16 in. over the diameter of the body of ⅞-in. bolts.

Diameter of rolled thread not more than 3/32 in. over the diameter of the body of 1-in. bolts.

Variation in dimensions of elliptical shoulders under head of bolt of 1/32 in.

11. The heads and nuts shall be free from checks or burrs of any kind. All finished pieces shall be smooth, straight, of uniform size, with well-shaped symmetrical bends and well-filled heads, free from injurious mechanical defects, and be finished in a first-class, workmanlike manner. The head shall be concentric with and firmly joined to the bottom of the bolt with the underside of the head at right angles to the body of the bolt. The threads on the bolts shall be rolled, unless otherwise specified, shall be full and clean and shall be made in section and pitch according to the purchaser's standard. The fit between threads on the bolt and nut shall be accurate and nut shall go on with a 10-in. wrench from second to fifth turn. The force to turn the nut completely on the bolt with a 24-in. wrench shall not be more than 60 nor less than 40 lb.

12. (a) The nuts shall be made of soft untreated steel and shall be ¼-in. thicker than the standard nuts used for untreated bolts. They shall be of sufficient strength to develop the ultimate breaking strength of the bolts.

(b) Nuts of standard thickness will be accepted at the option of the purchaser if proved to be of sufficient strength to equal the ultimate breaking strength of the bolts. The length of the bolts shall be correspondingly reduced.

**Branding**

13. The heads of the bolts shall bear the manufacturer's identification symbol. The letter "Q" shall be used to show that the bolts have been "quenched." If the bolts are also tempered, the letters "QT" shall be used to show that they have been "quenched and tempered."

**Marking and Shipping**

14. When the bolts are shipped they shall have the nuts applied for at least two threads, be well oiled to prevent rust, and shall be packed in securely hooped kegs of 200 lb. net. All kegs shall be plainly marked as to material, size of bolts and name of manufacturer.

**Inspection**

15. Tension and bend tests shall be made of the test specimens selected by the inspector from each lot of 50 kegs. One specimen shall be selected for each test, and if it meets the requirements of the specification, the lot will be accepted. If the test specimen fails, two additional specimens shall be tested in the same manner as the one which failed, and if they meet the requirements of the specification, the lot will be accepted. If, however, either one of the pieces fails, the lot will be rejected. Both tension and bend tests shall pass the requirements for acceptance.

## Specifications for Medium Carbon Steel Track Bolts with Nuts

**Access to Works**

1. Same as above.

**Place for Tests**

2. Same as above.

**Rejection at Destination**

3. Same as above.

**Material**

4. Material for bolts shall be steel made by the Open-Hearth or Bessemer process. It shall be homogeneous and when broken in tension, shall show a uniformly silky fracture. Material for nuts shall be of soft steel.

**Chemical Properties**

5. The chemical composition of each melt of steel from which track bolts are manufactured shall be within the following limits:

| Phosphorus, Maximum. | Per Cent. |
|---|---|
| Open-Hearth | 0.05 |
| Bessemer | 0.10 |

6. The manufacturer shall furnish the inspector a complete report of ladle analysis showing carbon, manganese, prosphorus and sulphur content of each melt represented in the finished material and any other elements used to obtain the specified physical properties. The purchaser may take a check analysis from the finished material; such analysis shall conform to the requirements of Section 5. The drillings for check analysis shall be taken parallel to the axis and from the end of the finished bolt.

**Physical Properties and Tests**

7. Track bolts shall conform to the following physical requirements:

| | |
|---|---|
| (a) Tensile strength, lb. per sq. in., minimum | 55,000 |
| (b) Yield point not less than 50 per cent of the ultimate breaking stress | |
| (c) Elongation, per cent in 2 in., not less than | $\frac{1,500,000}{\text{Ten. Str.}}$ |
| Minimum, 20 per cent. | |
| (d) Reduction in area not less than | $\frac{2,200,000}{\text{Ten. Str.}}$ |
| Minimum, 30 per cent. | |
| (e) Cold bending of the unthreaded part of the finished bolt without sign of fracture on the outside of the bent portion, through 180 deg. flat on itself. | |

8. All test specimens shall be from the finished bolts.

(a) The tension test specimens shall be about 4¼ in. long with threaded or unthreaded ends, and with the central 2-in. length turned to a ½-in. diameter, in accordance with the form and dimensions for tension test specimens of the American Society for Testing Materials.

**General Requirements**

9. Same as above.

11. The nuts shall be made of soft, untreated steel and shall be of sufficient strength to develop the ultimate breaking strength of the bolts.

**Branding**

12. Manufacturers' identification shall appear on the head of each bolt.

**Marking and Shipping**

13. Same as above.

**Inspection**

14. Tension and bend tests shall be made of the test specimens selected by the inspector from each lot of 50 kegs. One specimen shall be selected for each test, and if they meet the requirements of the specifications the lot will be accepted. If one of the test specimens fails, two additional specimens shall be tested in the same manner as the one which failed, and if they meet the requirements of the specifications, the lot will be accepted. If, however, either one of the specimens fails, the lot will be rejected. Both tension and bend tests shall pass the requirements for acceptance.

## Mill Practice

Information was gathered from the members of the Rail committee as to the results of their inspections of rail at the mills which were given in the paper on "Mill Inspections of Rail in 1915 and 1916." This paper gave the general results of the mill inspections of rail manufactured in 1915 and 1916 for some of the railroads and also gives some discussion of the specifications on which the rails were bought. According to these results the average top discard from the ingot, of all rails, was 17.9 per cent; the average elongation in the drop test was 14.5 per cent, and the rejections were 6.4 per cent. Of all rejections, 42 per cent were A rails.

## Intensity of Pressure and Rail Resistance

Extensive tests were made on the reciprocating wheel load machine at Sparrows Point, Md., dealing with the crushing effect on rail metal of various wheel loads. Small tapered holes were drilled through from side to side of the head of test rails at various distances below the top of the head and accurately fitted with tapered pins. Any flowage of the metal under rolling wheel loads would cause a flattening of the holes and its amount could be measured by the distance the pins lacked of going into their original position.

Dr. P. H. Dudley has made some extensive measurements on rails in track, of the areas of contact and the distribution of the intensity of the pressure within the area of contact. For the present, the only conclusions that can be drawn from the tests which have been made are but indications, as follows:

**Laboratory Tests:**

1. That for this section and composition of rail, initial loads of 30,000 lb. or more per wheel of cast iron and chilled tread, of 33 in. in diameter, were too great for the transverse holes, and produced flow or closure at least ⅜-in. below the bearing surface.

2. That loads of 25,000 lb. produced but slight flow or closure in the three uppermost transverse holes, and this extending not more than ¼ in. in depth.

3. That preliminary light loads, by cold-rolling the surface, may adapt the material to subsequent heavier loads.

**Field Tests:**

4. The diagrams of the plotted tables show that the stresses in the metals are locally less severe than we had expected to find in the surfaces of the pressure zone contacts of the wheel tread and the rail head.

5. It is important, as the theory and evidence show, that the metal of the circumjacent layer of each pressure zone of contact for the wheel tread, also that of the rail head, is in position not only to utilize the elasticity of the metal to help carry a given load, but to increase in area within the elastic limits of the metals nearly in proportion to the loads applied.

6. The action of the rolling wheels on the rail heads is a gradually applied load from zero to the maximum, then reducing again to zero, both for a unit length in the wheel tread or rail head, and is not a suddenly ap-applied load, even for a mile-a-minute or faster trains.

7. The round type of area of contact shows the greatest average unit intensity of pressure.

8. The longitudinal oval, or the transverse oval type indicates the lowest average unit intensity of pressure.

9. The longitudinal elliptical or transverse elliptical, in which the major axis is two or more times the width of the minor axis, indicates also a favorable average unit intensity of pressure.

10. The transverse oval or elliptical under steel or cast-iron wheels is more favorable for the rail head than the round.

11. The reciprocal relations of the loads carried on

the metal of the wheel treads to the metal of the rail heads should be studied from the voluminous service tests now available.

### Recommendations

The committee submitted the following recommendations:

1. That the locations for the physical test specimens and for chemical samples from rails as submitted with this report, be adopted by the Association to replace the diagrams shown on page 88 of the 1915 Manual.
2. That the "Specifications for Quenched Carbon and Quenched Alloy Steel Joint Bars," submitted with this report, be adopted by the Association and be substituted for the "Specifications for Heat-Treated, Oil-Quenched, Steel Joint Bars," on pages 91 to 93 of the 1915 Manual.
3. That the specifications for "Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts" and the "Specifications for Medium Carbon Steel Track Bolts with Nuts," submitted with this report, be adopted by the Association and be substituted for the "Specifications for Track Bolts," on pages 123 to 125 of the 1915 Manual.

The committee recommended that the same topics be reassigned for 1918 as were given the committee for the past year.

Committee: John D. Isaacs (S. P.), chairman; R. Montfort (L. & N.), vice-chairman; E. E. Adams (U. P.), E. B.. Ashby (L. V.), J. A. Atwood (P. & L. E.), A. S. Baldwin (I. C.), W. C. Barnes (S. P.), Chas. S. Churchill (N. & W.), W. C. Cushing (P. L. W.), G. M. Davidson (C. & N. W.), Dr. P. H. Dudley (N. Y. C.), J. M. R. Fairbairn (C. P. R.), L. C. Fritch (S. A. L.), A. W. Gibbs (P. R. R.), Howard G. Kelley (G. T.), C. F. Loweth (C. M. & St. P.), H. B. MacFarland (A. T. & S. F.), C. A. Morse (C. R. I. & P.), A. W. Newton (C. B. & Q.), J. R. Onderdonk (B. & O.), G. J. Ray (D. L. & W.), H. R. Safford (G. T.), J. P. Snow, F. S. Stevens (P. & R.), Earl Stimson (B. & O.), R. Trimble (P. L. W.), M. H. Wickhorst.

### Discussion

Mr. Churchill: The subjects assigned to this committee this year are the same as for the year previous, practically, and it will not be necessary to refer to them. The first matter upon which the committee desires action is the revision of the Manual as far as test pieces on rails are concerned. It will be recalled that the Manual shows test pieces from three positions, which it has been found unnecessary to have. I move that this revision of the Manual be adopted.

(Motion carried.)

M. H. Wickhorst (Rail Committee): The laboratory tests consisted of pieces of rail being rolled over, and in order to measure the deformation or flow of the metal, holes were drilled through the rails from side to side at different depths, some close to the top surface, and others lower, and some farther down. These holes were small in diameter, a little over $\frac{1}{16}$ in., fitted with tapered pins, so that a reduction in diameter of 0.000,01 in. could be measured by the distance the pin would go into the holes.

The results of these laboratory tests are given in the paper, and the rails were put into track for a field test. The rails in the laboratory tests were rolled over with a load finally of 35,000 lb. on one wheel. When put into the track the maximum load was perhaps 25,000 lb., and the average load less than that. It was found that there was considerable closure of the holes after the rails were in service a short time.

Mr. Churchill: We have prepared a specification on Track Bolts and Nutlocks. We also submit in appendix A, Specifications for Quenched Carbon and Quenched Alloy Steel Joint Bars. I make a motion that these specifications be adopted and printed in the Manual.

(Motion carried.)

Mr. Churchill: We also offer in appendix B, "Specifications for Quenched Carbon and Quenched Alloy Steel Track Bolts with Nuts."

I move that these specifications be adopted for printing in the Manual.

(Motion carried.)

Mr. Churchill: We give specifications for "Medium Carbon Steel Track Bolts with Nuts." I move that this be adopted for printing in the Manual.

(The motion was carried and the committee was dismissed with thanks.)

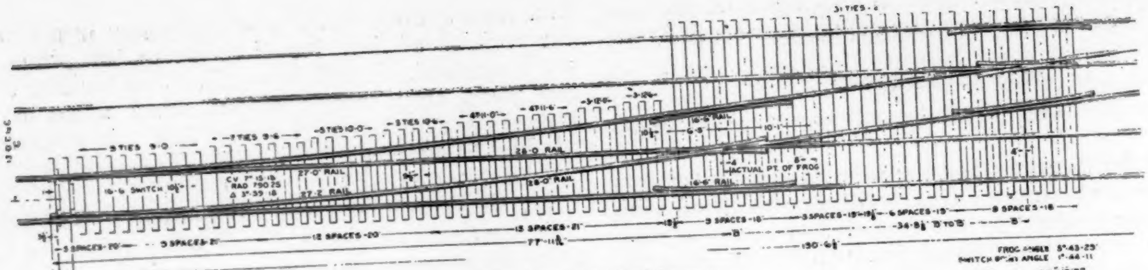
# Report of Committee on Track

A NUMBER OF CHANGES in the Manual were suggested of a detailed character and consisting principally in revisions of dimensions on the plans for standard turnouts and switches. Several changes in the spacing of ties throughout turnouts were recommended to make these dimensions agree with those on turnout plans. The committee did not believe it necessary to make any further changes in the specifications for tie plates for the present, but recommended that the revision of the tie plate specifications be given careful consideration by the next committee.

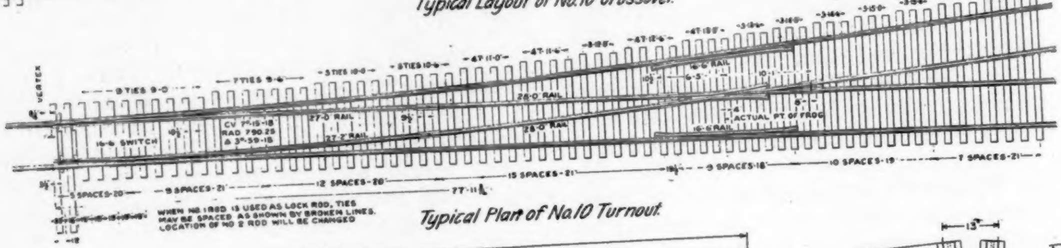
### Typical Plans of Turnouts, Crossovers, Slip-Switches and Double Crossovers

Drawings were submitted showing typical plan of a No. 10 turnout and a typical layout of a No. 10 crossover to conform with those now in the Manual for a No. 8 turnout and crossover.

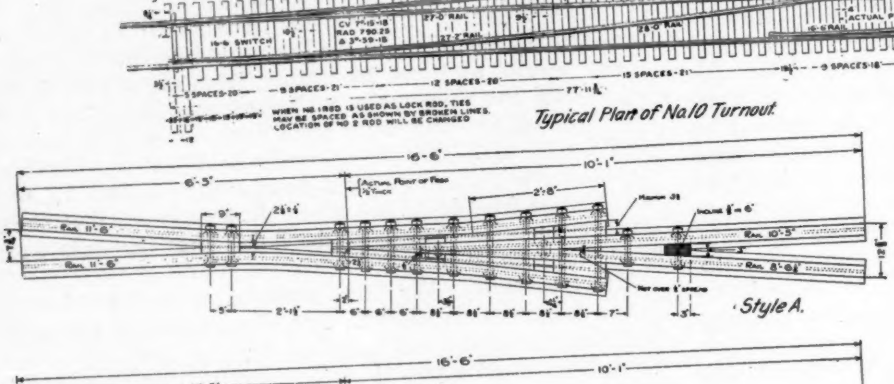
The 16 ft. 6 in., style "A," switch submitted is a development of 16 ft. 6 in. switch shown on page 176 of the 1915 Manual, with changes that were thought advisable. The throw has been recommended as $4\frac{1}{2}$ in. at center line of the switchhead rod, which brings the throw at the end of the point $4\frac{13}{16}$ in. The throw is specified at the end of the point to be not less than 4 in. or greater than 5 in. On page 178 in the 1915 Manual the throw is specified as 5 in. at the center of No. 1 rod, which would make the throw $5\frac{5}{16}$ in. at the point. The committee considers this excessive. The risers for style "A" switch are specified $\frac{5}{16}$-in., which affords a better shoulder for holding the stock rail in position, especially for heavy flange rails, than the $\frac{1}{4}$-in. specified on pages 178 and 179 of the 1915 Manual. The angle of planing the chamfer cut has been specified as 78 deg., as the 70-deg. angle specified on page 179 in the 1915 Manual is generally considered too abrupt and is not in common use. The switch point planing has been specified in much fuller detail and conforms to planing extensively used. The detail of slide plates has been specified to admit the use of a rectangular plate or of special rolled plates having risers narrower than the width of the plate, sufficient detail being given so that the plates and braces will be interchangeable. The heel plates have been specified to provide a shoulder, both for the lead rails and the stock rails, and the



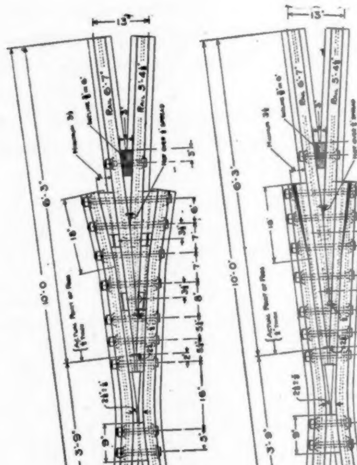
Typical Layout of No.10 Crossover.



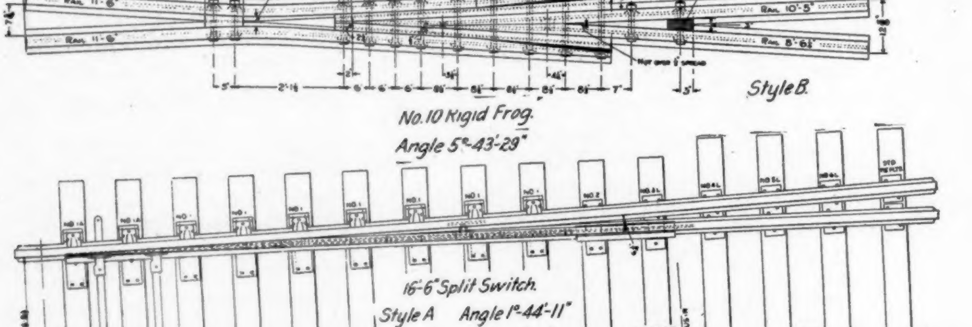

Typical Plan of No.10 Turnout



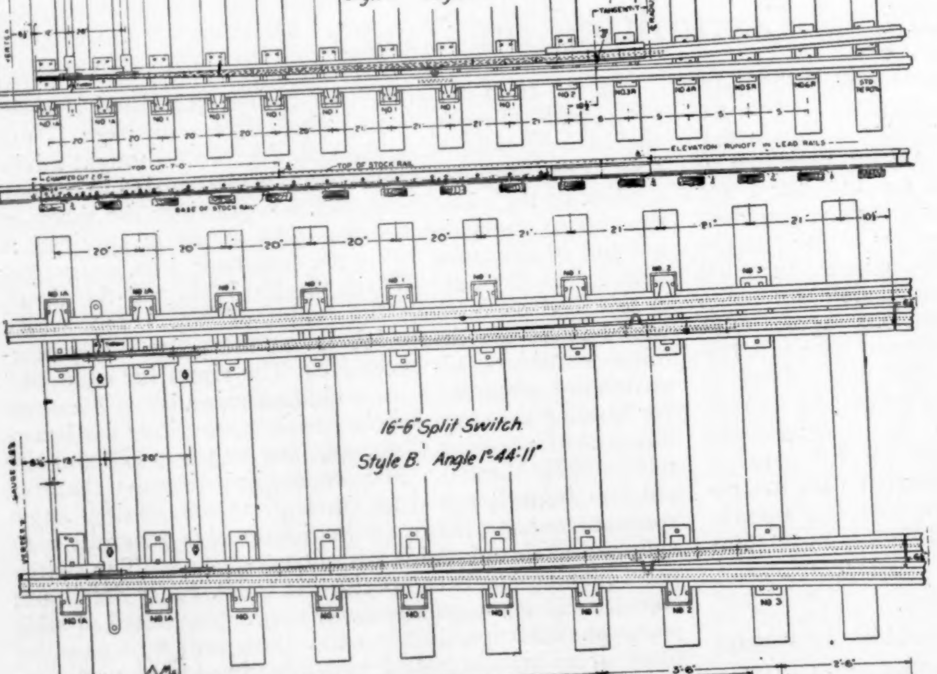

No.10 Rigid Frog.
Angle 5°-43'-29"



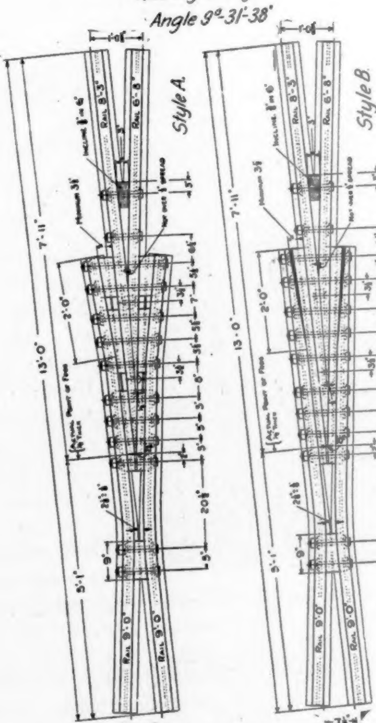

No.6 Rigid Frog.
Angle 9°-31'-38"



16'-6" Split Switch.
Style A Angle 1°-44'-11"



16'-6" Split Switch.
Style B. Angle 1°-44'-11"




No.8 Rigid Frog.
Angle 7°-09'-10"

tie spacing given so that the same detail of plates will apply for turnouts Nos. 7 to 10, inclusive. The bars are specified 1 in. by 2½ in., instead of ¾-in. by 2½ in., as specified on page 180 of the 1915 Manual, and other details to conform to heavier materials now being largely used.

The style "B" switch has been developed for use where materials for style "A" switch have been considered heavier than warranted on class B or class C railways, and also for emergency requirements. On the style "B" switch the plates have been detailed 6 in. wide and a lesser quantity than specified for the style "A" switch. The tie bars are ¾-in. by 2½ in., and reinforcing on one side only. The planing, spacing of tie bars, spread, throw and essential details are the same as specified for the style "A" switch. The style "B" switch is especially intended where the style "A" switch is considered too expensive, and where the track is not tie-plated throughout.

The No. 8 frog has been detailed 13 ft. long, instead of 13 ft. 6 in. long, as specified on page 184 in the 1915 Manual, the 6 in. difference in length being made on the heel end of the frog. This change will not interfere with the theoretical alinement data heretofore published. The reason for the change is so that a No. 8 frog will cut out of a 33 ft. rail without waste in cutting. This is an important item of economy. If the 13 ft. 6 in. length is maintained the frog would not cut economically out of a 33 ft. rail, unless the wing rails are made too short for a first-class frog.

The No. 10 frog has been detailed 16 ft. 6 in. long, conforming to the previous established length, and will cut out of a 33 ft. rail with comparatively little waste.

The No. 6 frog has been detailed 10 ft. long, as this length provides ample room for splice bars. A longer frog has been considered objectionable in a sharp turnout. Plans have been detailed for style "A" and style "B" frogs in each case. The style "A" frog, with cast filling, is similar to what is being used on many of the large eastern railroads, while the style "B" frog, with rolled filling, is similar to what is being used on many of the western railroads. Both styles of frogs are widely used and are proposed for standard without recommendations as to which is the best. The cost will be practically the same, and there are arguments in favor of each style.

### Reduction of Taper of Tread of Wheel to 1 in 38 and Canting the Rail Inward

At an early period in the history of car building it was found that a certain amount of cone in the tread of a new wheel was advantageous from many viewpoints. The amount of coning varied until in 1878 the ratio of 1 and 38 was adopted by the M. C. B. Association. This remained the standard until 1907, when the association revised the taper, making it 1 in 20, which is the present standard.

When a wheel rests on the rail, the location of the point of contact depends upon the taper of the wheel and the radius of the top of the rail. The normal position of the rails in track is with the vertical axes parallel and at right angles to the plane of the track. In this normal position the point of contact of wheels having a coning of 1 in 20 and rail of A. R. A. section with a 14-in. top radius of head is slightly less than ¾-in. inside of the center of the rail toward the gage side. For wheels having a coning of 1 in 38 the point of contact is slightly less than ⅜-in. inside of the center of rail toward the gage side.

This eccentric loading appears to be a condition that should be corrected. It has been the practice of section foremen to incline, or cant, the rail slightly to distribute wear over the top of the head. The result obtained is to bring the point of contact over the center of the rail. The heavier taper is carried on an inclined surface and produces stresses on the outside of the flange of the rail 40 per cent to 50 per cent greater than the stress on the inside flange due to outward thrust, as has been shown by the results obtained by the committee on "Stresses in Track."

It has been suggested that heavier coning with the resultant eccentric load on rail accounts for the location of transverse fissures on the gage side of the rail. While they are most common on the gage side, their appearance at the center and outside of the head would seem to indicate that they are developed in the line of contact or application of load. With the heavier coning the surface of the rail gradually wears to an inclined surface similar to the cone of the wheel. In this condition the abrasion of metal and slippage resistance is considerably increased.

Car wheel manufacturers have claimed that heavy taper supplies the condition favorable to true rolling motion and reduces to a minimum sliding of surfaces in contact.

Excessive wear on frogs is an objection to heavier coning. A wheel with a heavy cone trailing through a frog has its load carried by the narrow frog point and the load is not transferred to the wing rail until the frog point is passed. Theoretically, the drop from the frog point to the wing rail with a 1 in 20 tread having $\frac{5}{16}$-in. chamfer is very near ¼-in. The result is damage to the frog point, as the concentrated wheel load is too great for the narrow section of metal at the point.

Even though the heavy taper is better from the standpoint of wheel-wear, in view of the fact that rail must be designed for the heaviest wheel-loads while the wheels are designed for a definite car capacity, it may be expedient to sacrifice some degree of service of wheel to favor the factor of safety and life of rail.

The very general use of taper of 1 in 20 makes the proposed departure from this standard a move needing to be fully substantiated by theory and practice. The use of 1 in 38 taper by the New York Central Railroad and the use of 1 in 13 taper by the Baltimore & Ohio, the former being flatter and the latter heavier than M. C. B. standard, represents some considerable difference of opinion. In any change of taper it would appear desirable to have the taper uniform from the throat radius to the radius of the sand chill, or the full width of tread.

Thirty railroads, representing 95,000 miles, report the use of canted tie-plates. Of these, four roads, with 15,000 miles, report that the rail is canted by adzing the ties where canted tie-plates are not used. Fourteen roads, with 52,900 miles, report the general use of canted tie-plates. Ten roads, with 32,900 miles, report canted tie-plates used, but not generally. Nineteen roads, with 55,000 miles, report canted tie-plates with slope varying from 1 in 20 to 1 in 174.

From these general conditions it would seem that if the rail was installed and maintained so as to provide a uniform bearing and wear on the head of rail, the best results would be obtained from both wheel wear and rail wear. If the rail does not have the full and proper contact, as well as bearing on the tie-plates or on the tie, whether the tie-plates are canted or not, the best results cannot be secured.

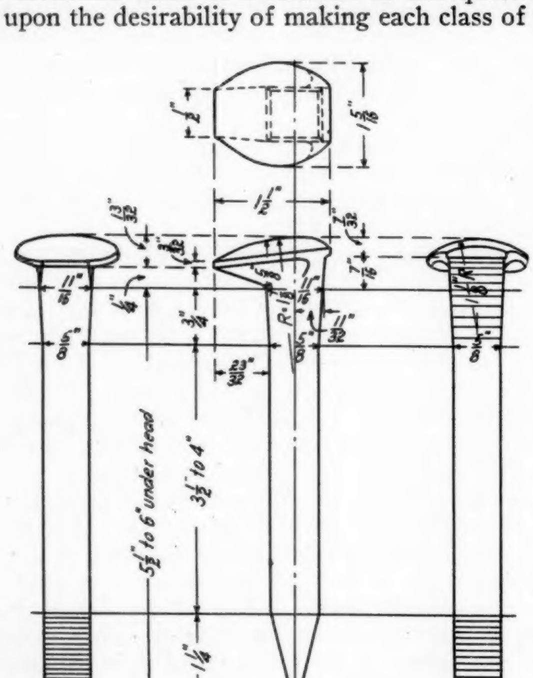
### Consider Design of Cut Track Spikes

During the past season the committee has made a careful canvass of several mills in the United States, and found a uniformity of opinion among the manufacturers

that the standard as proposed by the committee in 1917 cannot be made with the automatic machines now in use. We understand that the main difficulty is overcome by the Canadian mills by using special rolled bars a little over-size in one dimension. We can see no reason why the same practice could not be utilized by United States mills. Nevertheless, on account of this general complaint, and because of the present war conditions, the committee has decided to make a reduction in the amount of reinforcing under the head, and accordingly submit a revised design.

### The Effect of Fast Trains Upon the Cost of Maintenance of Way and Equipment

The economic value of a solution of this question depends upon the desirability of making each class of traffic




Revised Design of Track Spike

bear its own proportion of the total expense of transportation. There are three general speed classifications:

First and lowest: Commodity freight tonnage.

Second and intermediate: Merchandise and perishable freight tonnage.

Third and highest: Passenger traffic or tonnage.

The committee does not feel that it is prepared to offer a conclusive report until it has given the matter further study. We have made an analysis of the actual expense for maintenance of way and structures for the year reported by the Interstate Commerce Commission's report of 1914 on all of the railroads in the United States having a gross earning of one and one-half million dollars and over. These roads comprise somewhat over 213,000 miles, so that averages deduced from this one year's experience may be taken as at least indicative of the real effect on maintenance cost of increasing speeds.

In this analysis, high speed and low speed are considered as synonymous with passenger traffic and freight traffic. The committee is conscious that this is not an entirely true assumption, but it offers the only opportunity for classifying the expense as incurred by the railroads in accordance with speed differences.

In making the analysis of the expenses, the car mile was chosen as the common unit of the two classes of traffic, on the assumption that it measured more nearly the facilities required by each class of traffic than any other. The car mile and train mile were the only two common units reported by the Interstate Commerce Commission and, taken as a whole, there would be a fairly definite relation maintained between these two units so that the conclusions drawn would not be materially different, whichever unit is chosen. In making the analysis, a determination was made for each road; first, of the car miles per mile of road; second, the proportion of those car miles which were passenger car miles; third, the cost per mile of road for maintenance of way and structures.

In order to eliminate two of these three variables, the roads were grouped into classes:

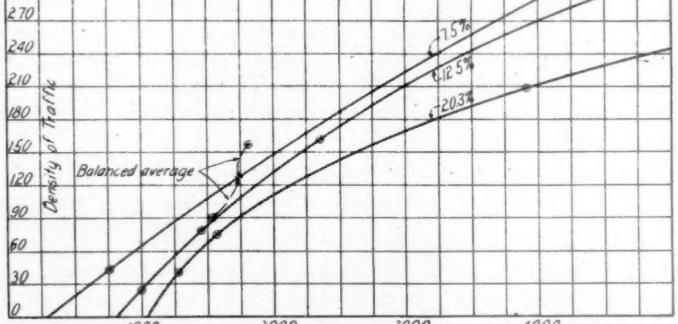
First, into groups of similar density of traffic, measured in car miles per mile of road.

Second, within each density group, roads of like per cent of passenger traffic were segregated.

The total car miles on all roads of like density and like per cent of passenger traffic were added, as were also the miles of road and the total cost of maintenance of way and structures. The total miles of road was divided into the total car miles, to get an average density, and the total miles of road was divided into the total cost to arrive at an average cost per mile of road for each group of like density and like per cent of passenger traffic. From the tables thus produced, there were picked out groups of like per cent passenger traffic and different densities of traffic. These groups of like per cent of passenger traffic were platted as shown in the accompanying diagram.

A separate line represents each of the various per cents of passenger traffic to a horizontal scale of the average cost of maintenance of way and structures per mile of road, and the vertical scale represents the density of traffic in thousands of car miles per mile of road.

Three lines only were platted, representing passenger traffic of 7.5 per cent, 12.5 per cent and 20.3 per cent of




Relation of Proportion of Passenger Traffic to Cost of Maintenance of Way and Structures

the total traffic. These particular percentages were chosen because a sufficiently large number of roads could be obtained at these per cents to produce more accurate plattings than of any other.

There are three factors which influence the cost of maintenance of way and structures:

(1) The elements, sometimes called weather stress.

(2) Density of traffic. (3) Character of traffic, here separated as between passenger and freight.

There may be a fourth factor, i. e., the ability of the management to regulate the expenditures in strict accordance with the demand of the traffic. If there be this fourth factor, it will lose force or disappear entirely

in the consideration of a large number of roads as is here done.

The three factors are disclosed by this chart, the weather stress being shown on the line of zero traffic, and having a different value for roads carrying different per cents of passenger traffic as might be expected because of the different amount and character of material entering into the construction of the lines doing these different kinds of business. The influence of the increased density of traffic on roads carrying a given proportion of passenger traffic is shown by all of the lines on the chart, showing an increased cost per mile of road with an increased density of traffic. The factor of increased cost due to speed (when used synonymous with passenger versus freight) is shown by the decreased cost per mile of road for any given density of traffic for the smaller proportions of passenger traffic.

The committee asked that this report be considered conclusive only in so far as passenger traffic versus freight traffic can be considered synonymous with fast speed versus low speed, and that the subject be referred back for further investigation and future report.

### Report on Whether Widening of the Flanges of the Wheels Would Not Be Detrimental to the Present Standard of Track Construction

The committee was requested by the Secretary to report to the Board on subject 9 before the fall meeting of the American Railway Association. We submit herewith copy of a letter sent to the Secretary on October 23, 1917:

"With reference to the subject assigned to the Association by the American Railway Association and referred to the Track committee relative to the contour of chilled car wheels, throat clearances for frogs, guard rails and crossings, and the effect of an increase of thickness of wheel flanges, I beg to advise that at the last meeting of the Track committee, held in Chicago, October 15, the chairman was directed to send you the following communication:

"The Track committee is willing to agree that the flanges can be increased, as recommended by the Chilled Car Wheel people, without any serious detriment from a track standpoint, provided:

"(1) That the wheels are in all cases accurately mounted to $\frac{3}{16}$-in. additional spread gage;

"(2) That the allowable flange wear before wheels are removed be changed so that wheels will be removed when the flange is worn to within $\frac{3}{16}$-in. of the present limit of removal;

"(3) That more care be used in matching wheels on any given axle on account of the reduction in play and the corresponding reduction in compensation from coning;

"(4) That this flange width be confined to flanges of four-wheel freight car trucks;

"(5) That this conclusion on the part of the Track committee be not construed as an invitation to increase the axle load.

"With the above provisions, it is believed that it will be unnecessary to make any difference in the width of flangeway of frogs and crossings, or change the present method of track construction."

### Conclusions

The committee makes the following definite recommendations to the Association:

*Receive as Progress Report*

(To be considered further at the next convention.)

Subject 2 plans submitted for:

Typical plan of No. 10 turnout and typical layout of No. 10 crossover;
16 ft. 6 in. split switch, style "A."
16 ft. 6 in. split switch, style "A" details.
16 ft. 6 in. split switch, style "B."
16 ft. 6 in. split switch, style "B" details.
No. 8 rigid frog, style "A" and style "B."
No. 10 rigid frog, style "A" and style "B."
No. 6 rigid frog, style "A" and style "B."
Sections and details for rigid frogs.

*For Adoption and Publication in the Manual*

Subject (1) Proposed revisions to be made in the Manual.

Subject (5) Proposed specifications for relayer rails for various uses.

Subject (7) Proposed design of cut track spike.

*Accept as Information*

Subject (3) Report on reduction of taper of tread of wheel to 1 in 38, and on canting the rail inward.

Subject (8) Report upon the effect of fast trains upon the cost of maintenance of way and equipment.

Subject (9) Report on whether widening of the flange of the wheels would not be detrimental to the present standard of track construction.

*Future Work*

The continuation of subjects 1, 2, 3, 4, 6, 8 and 9.

Committee: G. J. Ray (D. L. & W.), chairman; J. R. Leighty (M. P.), vice-chairman; M. C. Blanchard (A. T. & S. F.), Geo. H. Bremner (I. C. C.), H. M. Church (B. & O.), Garrett Davis (C. R. I. & P.), A. L. Grandy (P. M.), G. W. Hegel (C. J.), T. H. Hickey (M. C.), T. T. Irving (G. T.), J. B. Jenkins (B. & O.), H. A. Lloyd (Erie), F. H. McGuigan, Jr., (G. T.), J. V. Neubert (N. Y. C.), R. M. Pearce (P. & L. E.), C. D. Perkins (N. Y. N. H. & H.), H. T. Porter (B. & L. E.), Thomas Quigley (I. C.), J. B. Strong (Ramapo Iron Works), W. P. Wiltsee (N. & W.).

### Discussion

E. R. Leighty (Vice-Chairman): In connection with subject No. 2, in preliminary explanation of this plan for type A switch, I would say that there seemed to be a demand for a switch which was of somewhat stronger construction than the switch that is ordinarily used to meet that demand, and type A switch has been designed for that purpose. This report is not offered for the purpose of going into the matter this year.

Mr. Leighty: The statement in regard to subject 3 is submitted as information only, and we ask you to receive it as such and have it printed in the Proceedings.

The President: This is an important matter, and we will be glad to have written discussion on this subject.

Mr. Leighty: As to the fourth subject, this is a matter which has been before the association for some years, and we have had progress reports on it during the last few years, and nothing specially important has developed in the past year to warrant taking up time and space to make a report on it.

With reference to the fifth subject, we are asking that this subject be referred back to the committee to straighten out.

The President: The committee's suggestion will be accepted.

Mr. Leighty: With reference to subject 7, the design of cut track spikes, I move that the matter we present be adopted for printing in the Manual.

(Motion carried.)

Mr. Leighty: With regard to the 8th subject, the effect of fast trains upon the cost of maintenance of way and equipment, what we present is the beginning of an

investigation of this subject and is submitted as information only.

The President: This seems to be the beginning of an interesting subject.

A. B. Talbot (U. of Ill.): The data which are given in the chart is very interesting, and it seems to me it is worth while to call attention to the results which come from this diagram.

C. E. Lindsay (N. Y. C.): Will the committee give a statement regarding the weather stress?

Mr. Leighty: One of the costs of the maintenance of way structures is called weather stress, which is the course that would have to be incurred to keep the tracks and other facilities in operating condition, or in the same operating condition as when constructed, provided they were not used for traffic. This cost per mile of road is reduced down to the line of zero traffic. That is a projection carrying the averages found from the roads where there is traffic, but when they are projected down to zero traffic we have an indication of what could be expected to be the weather stress cost on the different character of lines.

Mr. Lindsay: Why does the committee use "miles of road" instead of "miles of track?"

Mr. Leighty: Because we automatically use all the facilities required for increasing the traffic. If we used "miles of track" we would at once have to begin to adjust matters, and what we were after was to find the overhead or entire average cost.

The matter which we submit covering the 9th subject is submitted as information. It does not properly belong in the Manual, and the only action we can take, under the instruction we had, was that it be submitted as information to the American Railway Association.

(The committee was dismissed, with the thanks of the association.)

# Report of Committee on Wood Preservation

The committee reported progress on the subjects assigned. But little work was accomplished during the year, as the members were widely scattered and busily engaged with their regular work, which the war conditions have made increasingly exacting. The work of the committee is now of such a nature that it requires laborious experimental and research work and subsequent study to arrive at conclusions, all of which must be done by the individual effort of the members, so that under conditions such as prevailed during the past year but little can be accomplished.

It is the recommendation of the committee that the program assigned for this year be continued the coming year and that in addition it should report on:

(1) The preservative treatment of Douglas fir.

(2) Indicators for determining penetration of the preservative in freshly Burnettized ties and timbers.

Committee: Earl Stimson (B. & O.), chairman; C. M. Taylor (P. & R.), vice-chairman; F. J. Angier (B. & O.), F. C. L. Bond, E. H. Bowser (I. C.), J. F. Burns (L. & N.), W. A. Fisher, C. F. Ford (C. R. I. & P.), C. J. Graff (N. Y. C.), R. H. Howard (Wabash), C. H. R. Howe (B. & O. S W.), J. E. Johnson (M. C.), George E. Rex (A. T. & S. F.), H. Stephens (N. Y. C.), E. A. Sterling, Lowry Smith (N. P.), O. C. Steinmayer (St. L.-S. F.), C. H. Teesdale, Dr. Hermann von Schrenk, J. H. Waterman (C. B. & Q.).

(The report was presented by the chairman by title only and without any discussion.)

## Closing Business

Just prior to the installation of officers yesterday afternoon several resolutions were presented, among which were the following:

To the Honorable Wm. G. McAdoo,
Director-General, Washington.

The American Railway Engineering Association, in convention assembled, expresses its desire to render all possible assistance to you and your staff in maintaining the high degree of efficiency of railway operation and maintenance so essential to an early victory in the great world-wide conflict. The members are principally officers in railway service, although some are in government and other branches of engineering service related to railways operating on the North American continent. They are intensely interested in the many problems incidental to the construction, maintenance and operation of railways and particularly in the standardization of materials and methods of doing work. We are hopeful that our efforts may be the means of assistance to the Federal Government and that you will feel free to call upon us for such assistance.

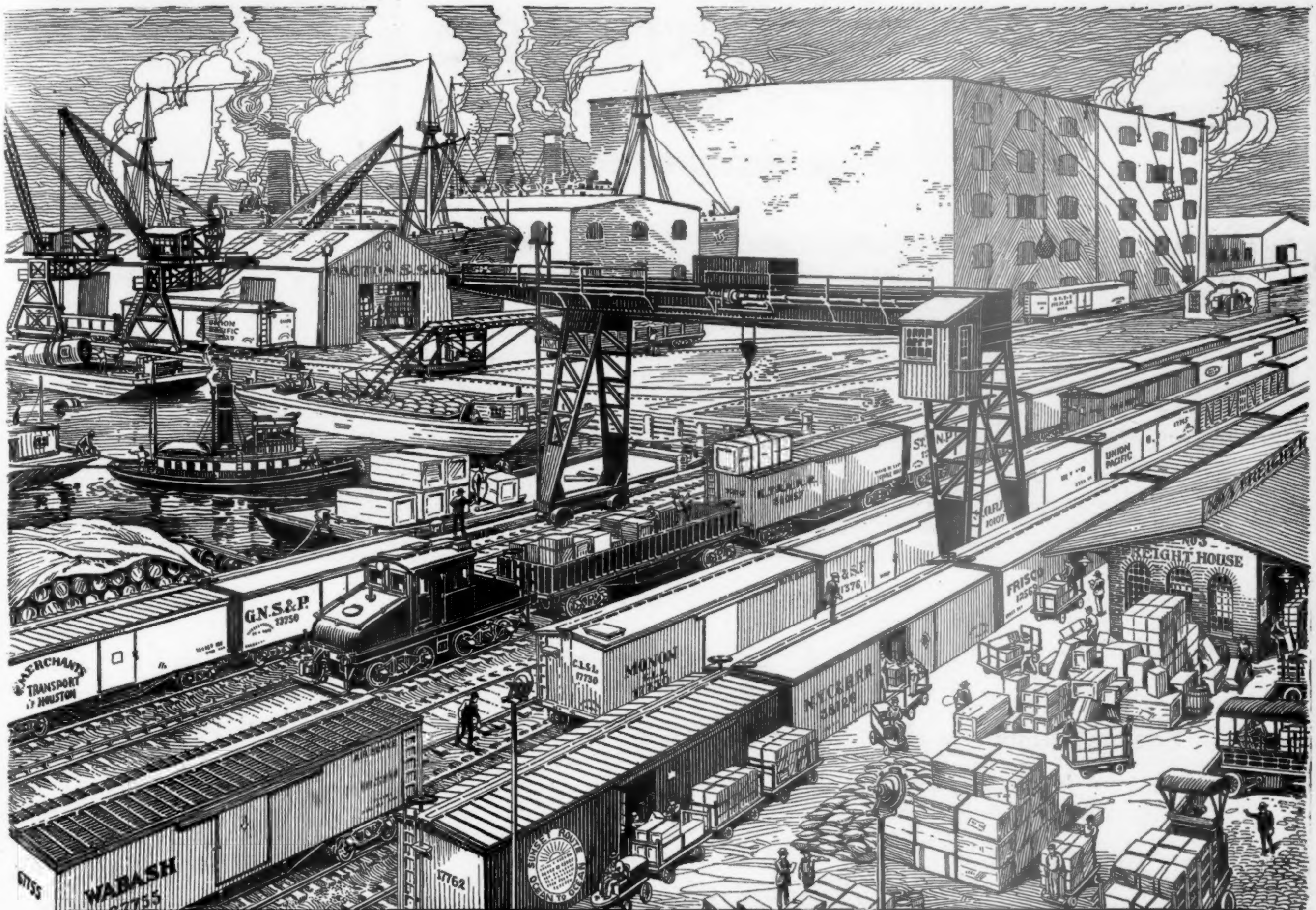
Among other resolutions adopted was one calling attention to the shortage of creosote and to the fact that large quantities of coal tar are now being burned as fuel in the steel mills. In view of the importance of protecting timber against decay this resolution stated, "In view of the above factors the American Railway Engineering Association respectfully suggests to the Railway Administration at Washington that an investigation be undertaken to determine whether it will be possible to adjust the burning of the crude coal tar by the steel companies in such manner that steel production will not be interfered with and at the same time a certain amount of the tar now being burned can be released to the tar distillers and thereby increase the amount of creosote oil available."

## A. R. E. A. Registration

Bachelder, F. J., Consulting Engineer, Chicago, Ill.
Barrett, W. C., Div. Eng., Lehigh Valley R. R., Sayre, Pa.
Bates, Onward, Con. Eng., Chicago.
Billman, H. E., Gen. R. M., Mo. Pac. R. R., St. Louis, Mo.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Clement, S. B., Chief Eng., T. & N. O. Ry., North Bay, Ont.
Conner, J. K., Chief Eng., L. E. & W. R. R., Indianapolis.
Downs, J. L., Roadmaster, I. C. R. R., Memphis, Tenn.
Gilbert, G. H., Eng. B. & B., Sou. Ry., Cincinnati, O.
Gowdy, R. C., Ch. Eng., F. W. & D. Ry., Ft. Worth, Tex.
Haggander, G. A., Bridge Eng., C. B. & Q. Ry., Chicago, Ill.
Hynes, M. V., Gen. Supt., C. I. & W. R. R., Indianapolis, Ind.
Laird, H. G., Supt. Timber Pres., A. C. Line, Gainesville, Fla.
McCalman, D. S., Danville, Ill.
Mitchell, L. A., Supt. Roadway and Bldgs., Union Tr. Co. of Ind., Anderson, Ind.
Podmore, J. M., Div. Eng., N. Y. C. R. R., Toledo, Ohio.
Rose, L. S., Eng. in Ch. of Val., Big Four Ry., Cincinnati, O.
Sharvey, O. L., Val. Eng., M. C. R. R., Detroit.
Stimson, Earl (Second Vice-President), Eng. M. W., B. & O. R. R., Baltimore, Md.
Turneaure, F. E., Dean, Col. of Engr., U. W., Madison, Wis.

### Guests

Snyder, J. A., Asst. Eng., M. C. R. R., Chicago, Ill.
MacNeill, D. A., Can. Govt. Rys., Moncton, N. B., Canada.
Geills, A., Genl. Roadmaster, St. Thomas.
Neptune, W. M., Asst. Eng., Mo. Pac. R. R., St. Louis, Mo.
Case, M. B., Res. Eng., Paducah & Ill. Ry., Metropolis, Ill.
McDougall, N. R., C. & W. T. R. R. Co., Chicago, Ill.
Idle, H. J., Val. Dept., C. R. I. & P. Ry., Chicago, Ill.
McEllis, Frank, Asst Secy., A. R. E. A., Chicago, Ill.

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